BETHLEHEM

CARBON STEEL BARS AND SPECIAL SECTIONS

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA

BETHLEHEM

Carbon Steel Bars
and
Special Sections
with

PROFILES, TABLES, SPECIFICATIONS
AND DATA RELATING TO BARS

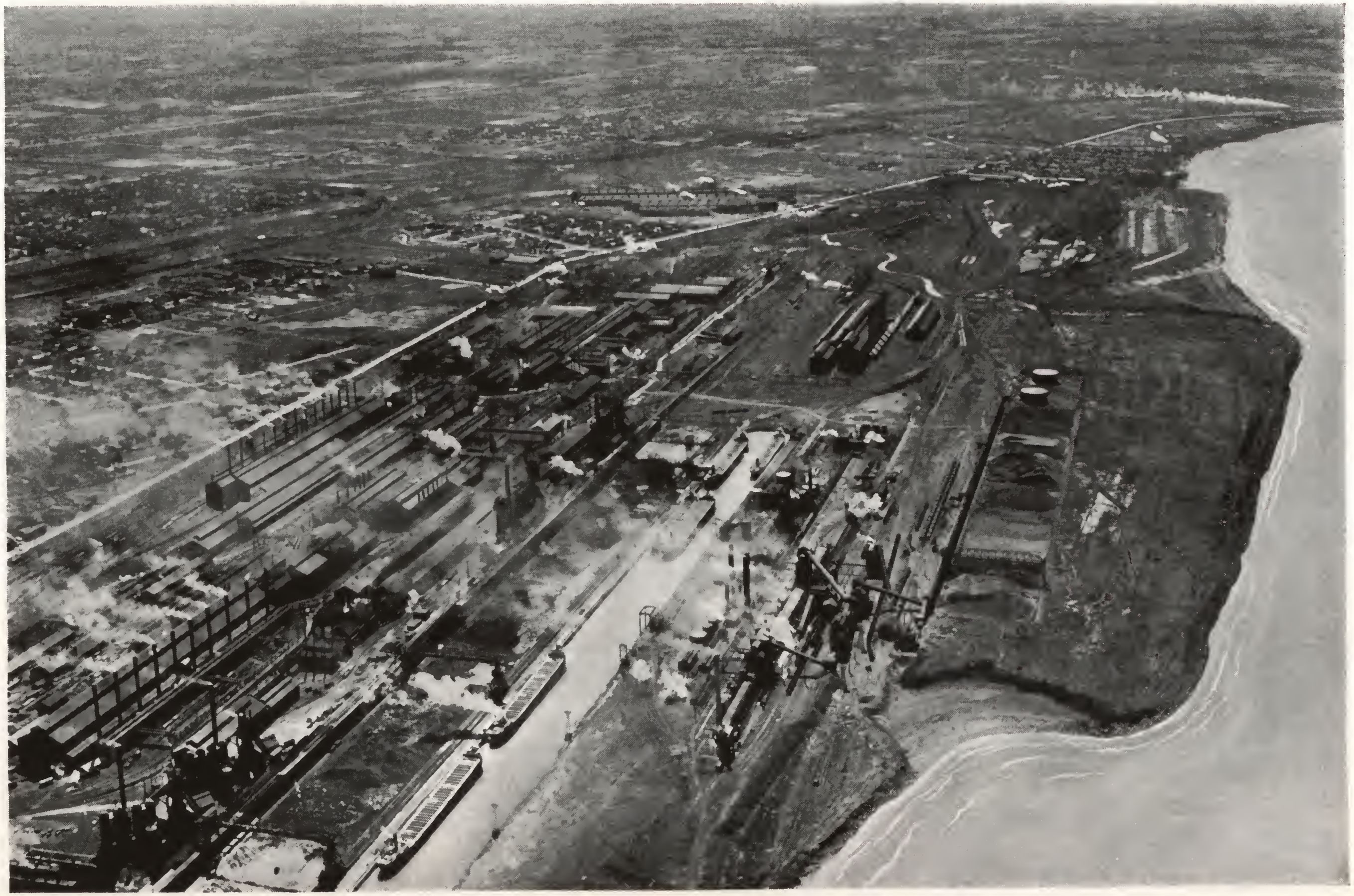
CATALOG—144

1937

BETHLEHEM STEEL COMPANY

GENERAL OFFICES BETHLEHEM, PA.

Air view of the Gautier mills of the Cambria plant, Johnstown, Pa.



Airplane view of part of Lackawanna plant, Lackawanna, N. Y.

TABLE OF CONTENTS

PREFACE

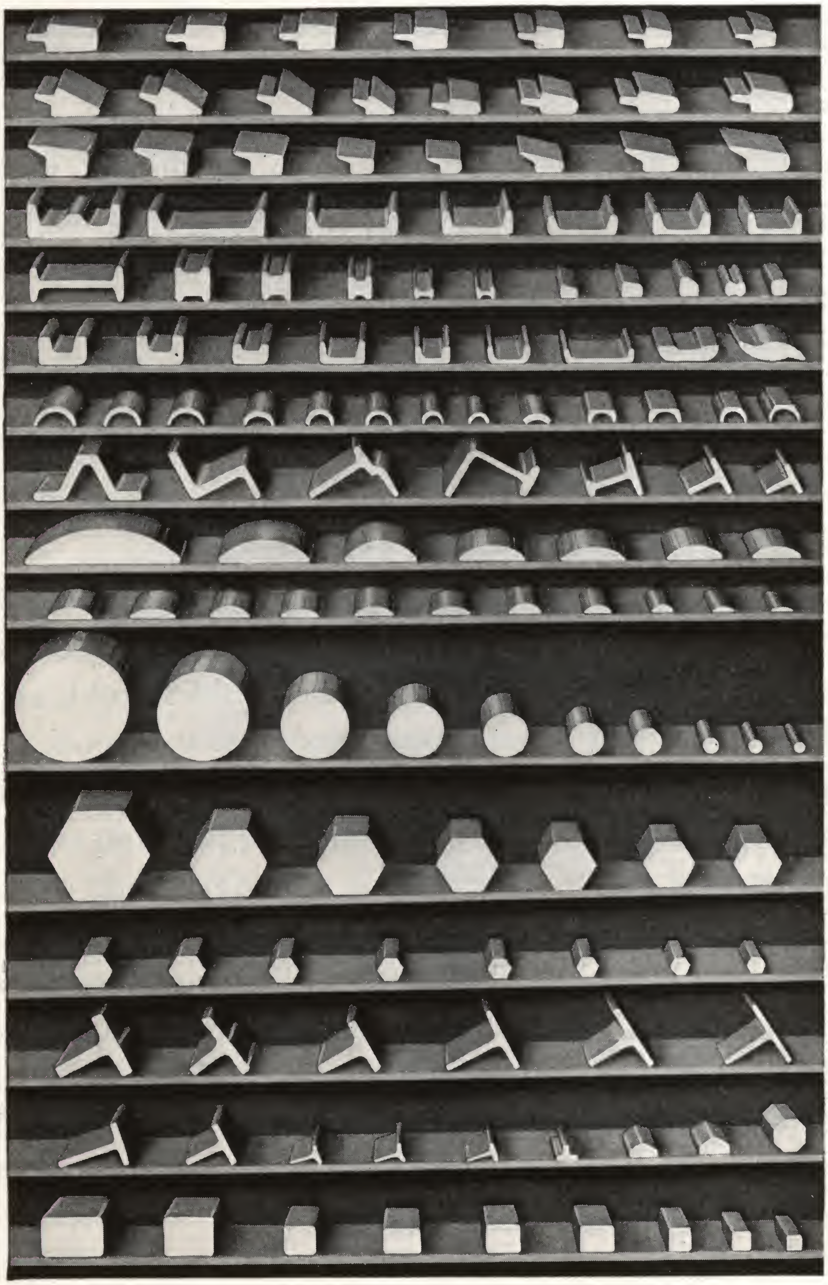
The bars and special sections shown in this book are representative of the carbon steel products rolled on the bar mills of Bethlehem Steel Company.

Quality is the primary object in all stages of production. The final product will be found accurate in dimensions, satisfactory in straightness and finish, chemically within the specified limits, and will possess the proper hardness and hardening characteristics for further processing and ultimate use.

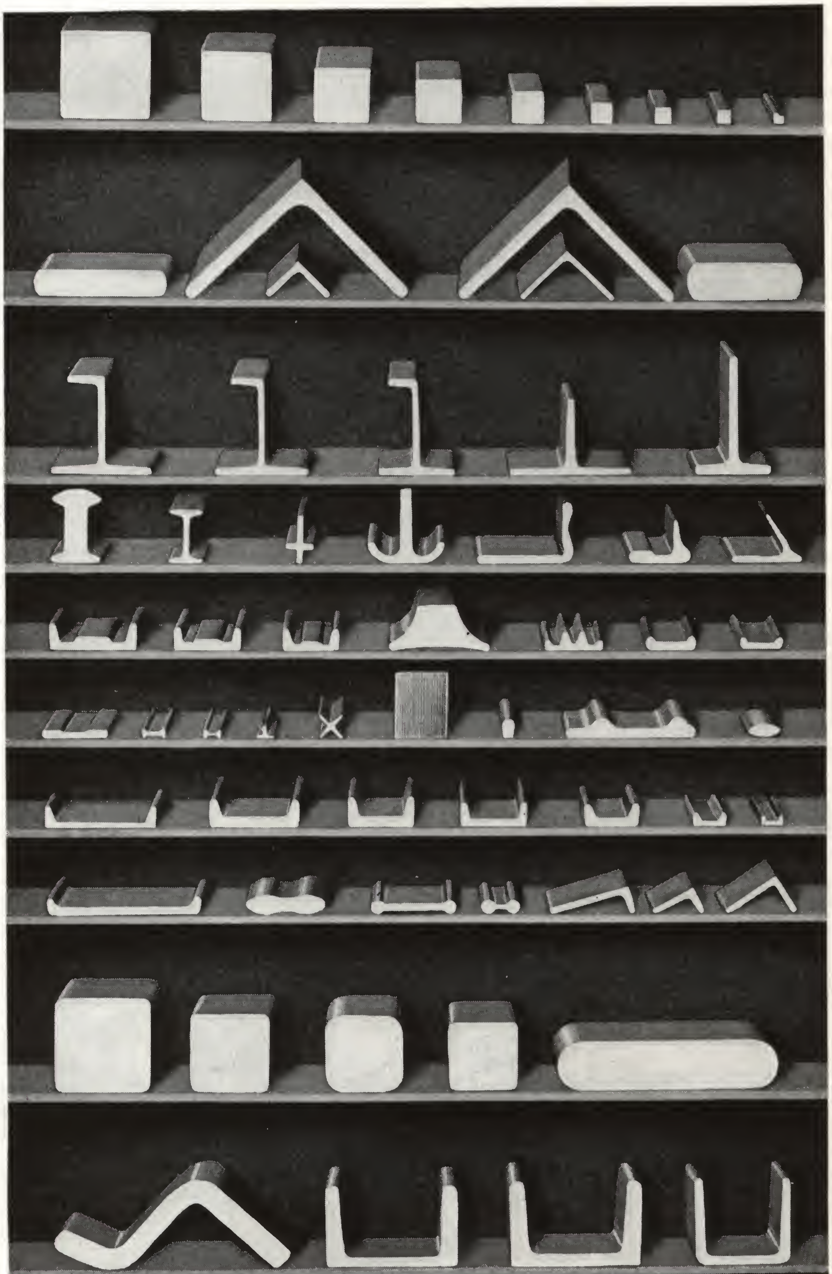
Rigid metallurgical supervision of the raw materials and of the open hearth or bessemer operations, with liberal discard, proper surface preparation, control of rolling and cooling temperatures, coupled with careful final inspection, all contribute to the high quality of the product.

In a presentation of this nature, it is impossible to furnish complete and detailed information on all of the subjects presented. The Bethlehem policy is to consider problems of customers as part of the usual procedure and to offer the fullest cooperation. A corps of engineers is maintained for the purpose of assisting in the solution of problems or with development of details pertaining to design, grade or type of steel, chemistry, machinability, or other points that arise in connection with steel products and their processing and use. A cordial invitation is extended to the users of carbon steel bars to avail themselves of this service, and to visit the Bethlehem plants to become acquainted with the personnel which is responsible for the quality of the Bethlehem bars and special sections

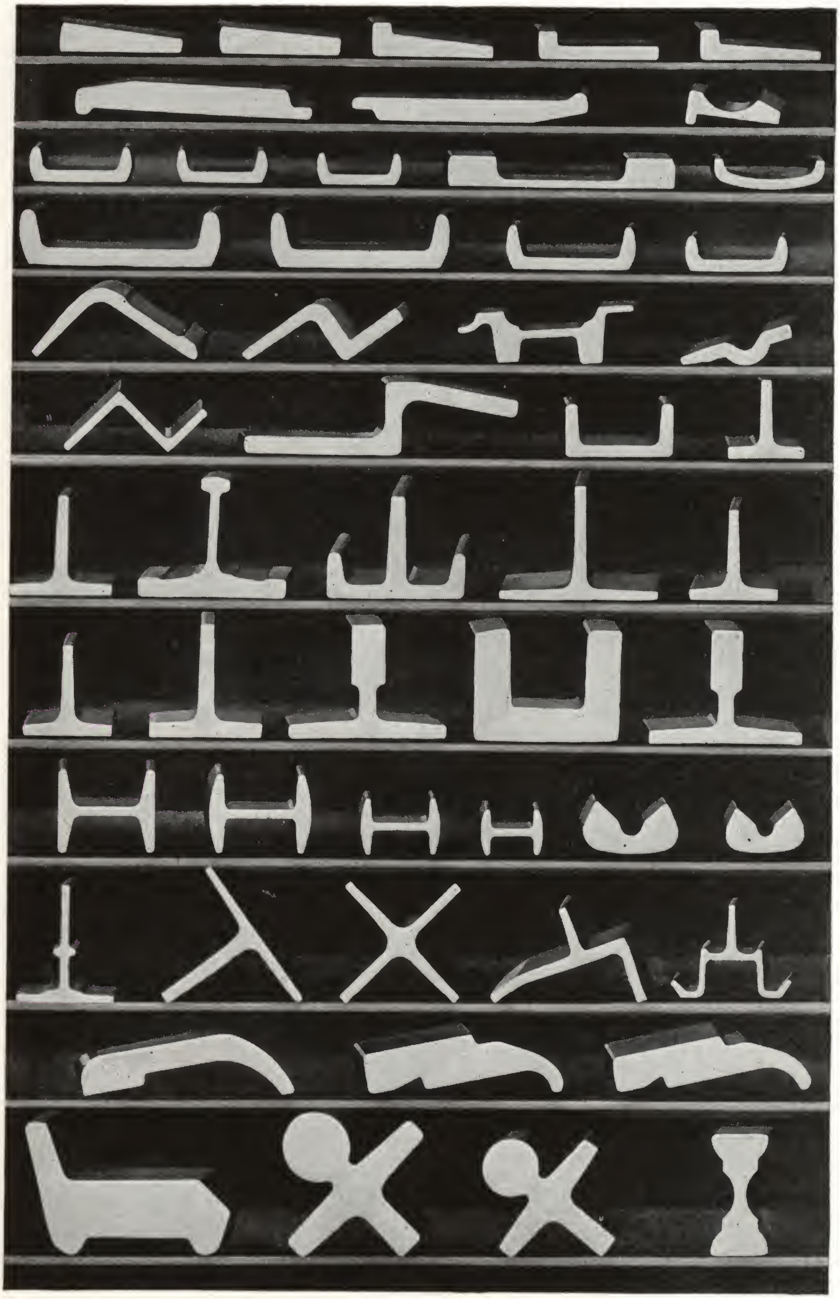
REPRESENTATIVE SECTIONS



REPRESENTATIVE SECTIONS



REPRESENTATIVE SECTIONS



REPRESENTATIVE SECTIONS

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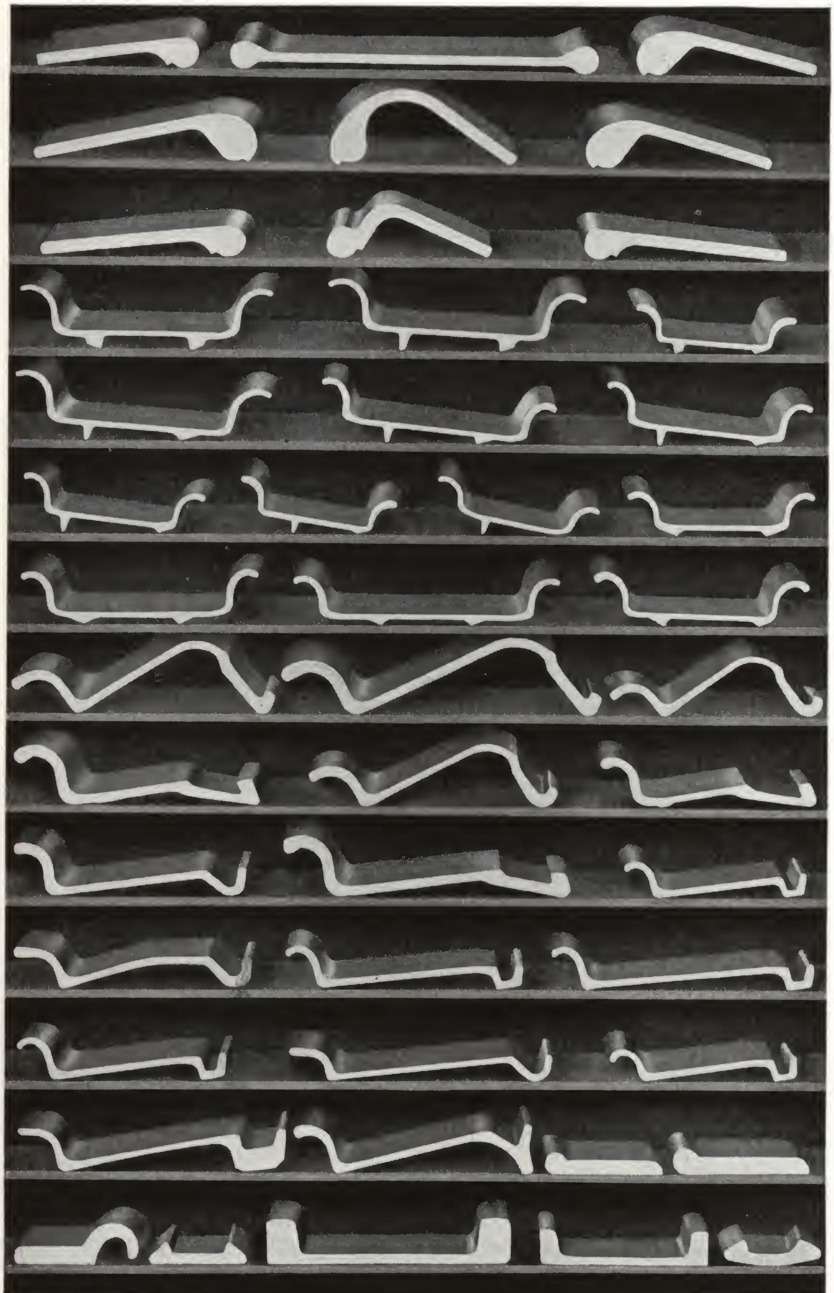
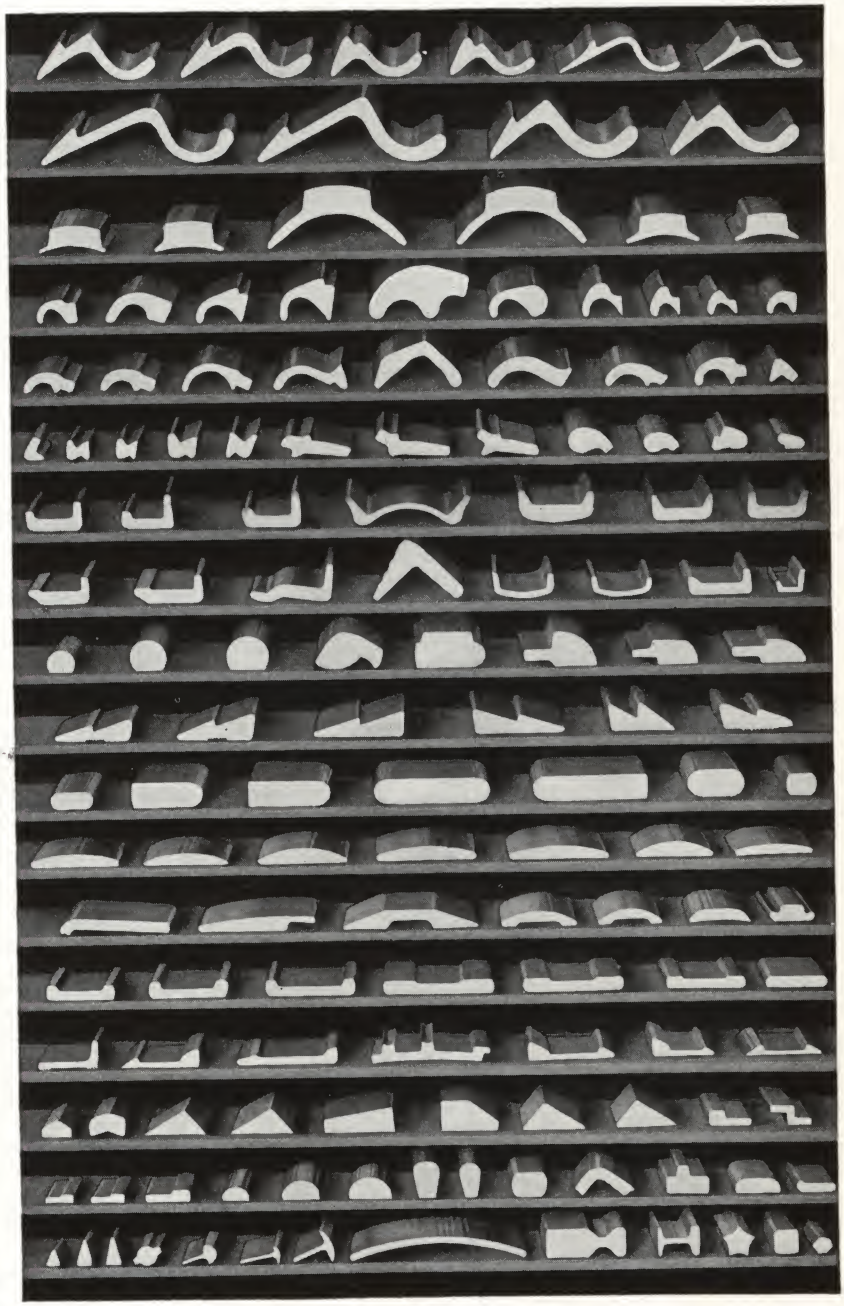


REPRESENTATIVE SECTIONS



REPRESENTATIVE SECTIONS

PRODUCTION FACILITIES

BETHLEHEM'S CARBON STEEL BAR PRODUCTION FACILITIES

BETHLEHEM STEEL COMPANY'S carbon steel bars and special sections are rolled in the following plants:

EASTERN PLANTS AND LOCATIONS

Bethlehem, Bethlehem, Pa.	Lebanon, Lebanon, Pa.
Cambria, Johnstown, Pa.	Maryland, Sparrows Point, Md.
Lackawanna, Lackawanna, N. Y.	Steelton, Steelton, Pa.

PACIFIC COAST PLANTS AND LOCATIONS

South San Francisco, Cal.	Seattle, Wash.	Los Angeles, Cal.

Bethlehem's vast resources of coal, stone, and ore assure the maintenance of the proper grade of pig iron to supply its steel-making plants. The supply of scrap used in the open hearth charge is also carefully controlled by corps of trained men who inspect it. Scrap preparation units located at each steel-making plant make possible the best charge for the grade of steel to be produced.

Sufficient steel-making capacity, including acid and basic open hearth furnaces and bessemer converters, is available amply to provide the mills with all types and grades of carbon steels.

Coke being pushed out from coke oven

The Bethlehem mills are arranged so that they can produce practically any size bar, and a large variety of special sections.
The Gautier mills, which have a wide reputation for rolling special or unusual sections, are located at Johnstown, Pa.

General view of a blast furnace

Coiling equipment is available so that a large number of sections can be obtained in coils.

Each steel-making plant has complete chemical, physical and metallographic laboratories. Pickling facilities and adequate chipping bed capacity insure well prepared stocks for subsequent operations.

The Bethlehem metallurgical control covers a very broad field, including the selection and checking of all raw materials, material in process and the final product. All experimental and development projects of a metallurgical nature are within its scope. In addition to the usual regular and routine inspection at each individual mill, there are set aside at each plant well-lighted areas for special inspection.

Included in the metallurgical control organization at each plant is a group of trained men, known as "observers," who follow all operations from the introduction of the ore into the blast furnaces to the completion of the last metallurgical operation. These men do not function as mechanical or detail inspectors. Bethlehem

Charging an open hearth furnace

has laid down fixed standards and set up practices to be maintained in each of the operations for each grade of steel. The observers' duties are to see that these standards are rigidly adhered to, and this group of men are held responsible for the quality of the product. Any time the standard is not being maintained, they have the authority to stop the operation, and reject the steel regardless of the reason.

Bethlehem maintains close service contact with customers through a group of trained men. The duties of this group are to provide metallurgical service to customers, and to furnish the mill organizations with pertinent information regarding details of operations which will assure customers the most satisfactory products. The customer's metallurgical problems are considered by Bethlehem as a mutual responsibility and their solution a dual achievement.

The very important function of issuing complete metallurgical instructions to the operating or production personnel is given the

Tapping open hearth furnace at the back. Note metallurgical observer taking temperature with optical pyrometer in order to issue instructions on holding interval and rate of teeming

Beginning of a blow in the bessemer converter

closest attention. This means covering not only what is printed in the specifications but also that which, by experience and continuous interchange of information with customers, is known to be necessary to furnish satisfactory products.

More emphasis is being placed daily on research in industry. A technical Development and Research department is maintained, entirely independent of the plant operating and metallurgical departments. This department has two general objectives as follows:

First — To add to the accumulated knowledge, both scientific and commercial, of existing steel products.

Second — To improve the quality and expand the uses of steel, either in old or new forms.

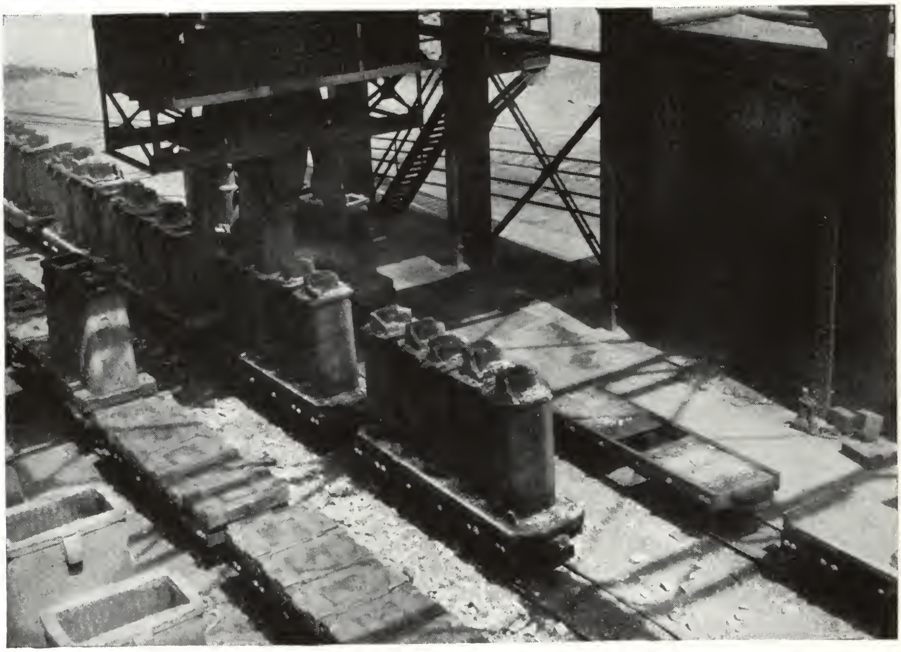
The organization of these allied departments is such that close cooperation is maintained at all times. This coordination of practical experience and scientific knowledge, combined with the selection of raw materials and the use of practically unlimited manufacturing facilities, is assurance of high quality in the final product.

Blowing bessemer converter

Pouring blown metal from a bessemer converter

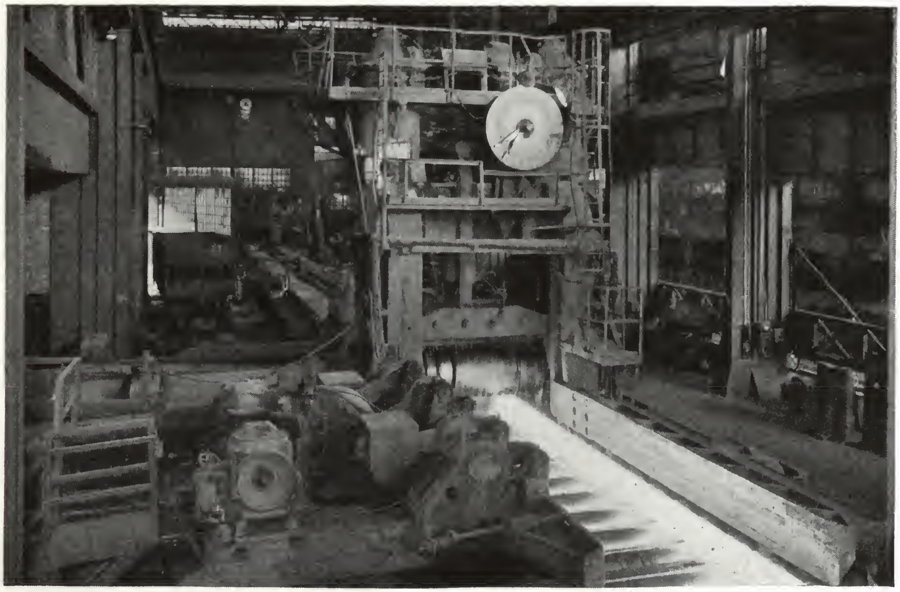
Pouring hot-top ingots

General view of open hearth pit

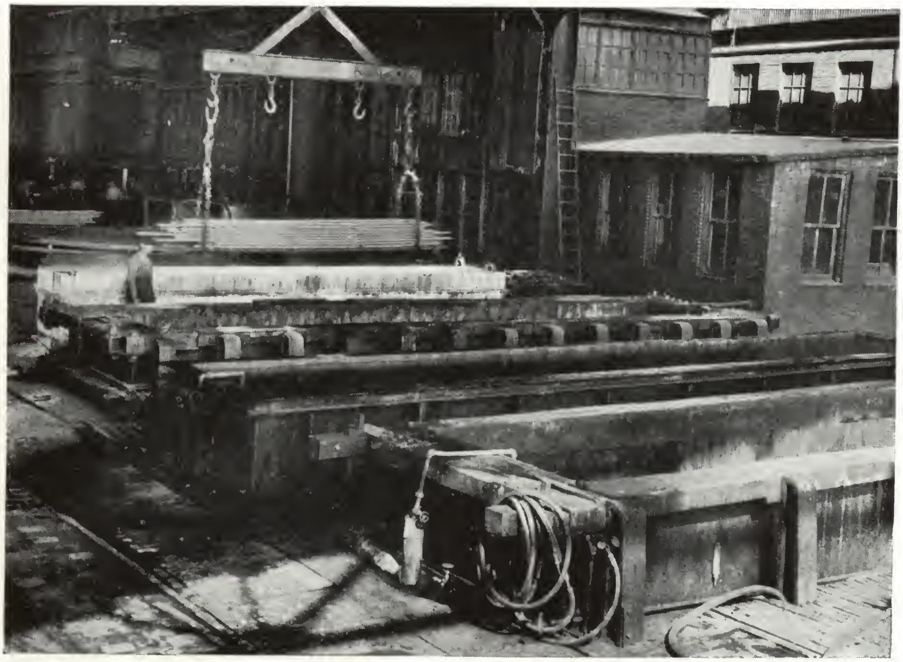


Stripping open hearth ingots

Charging an ingot into a soaking pit



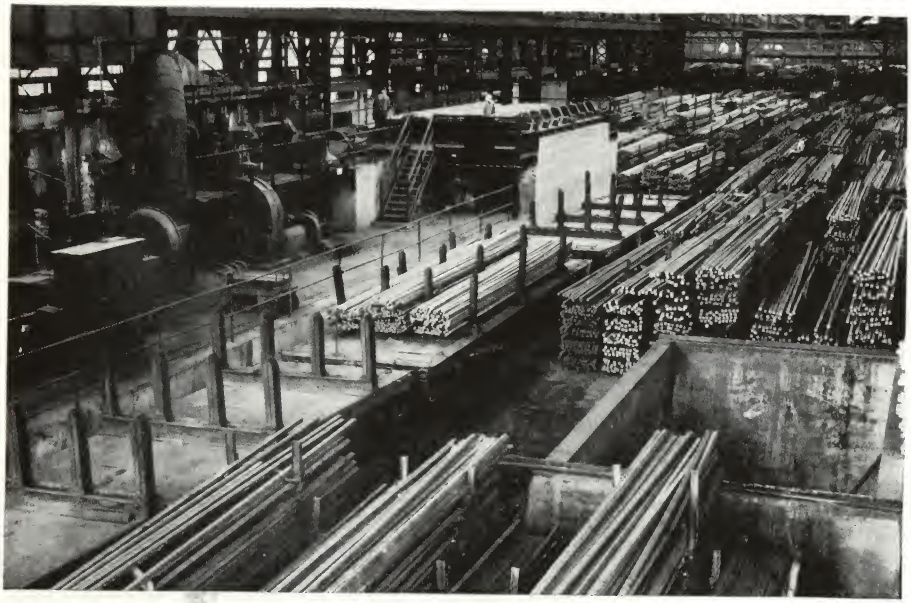
Rolling an ingot on a blooming mill at the Lackawanna plant



Pickling tanks for blooms and billets to clean surfaces for inspection

30-inch continuous billet mill at the Lackawanna plant

Section of chipping beds and two machines for preparing surfaces of blooms by removing surface imperfections



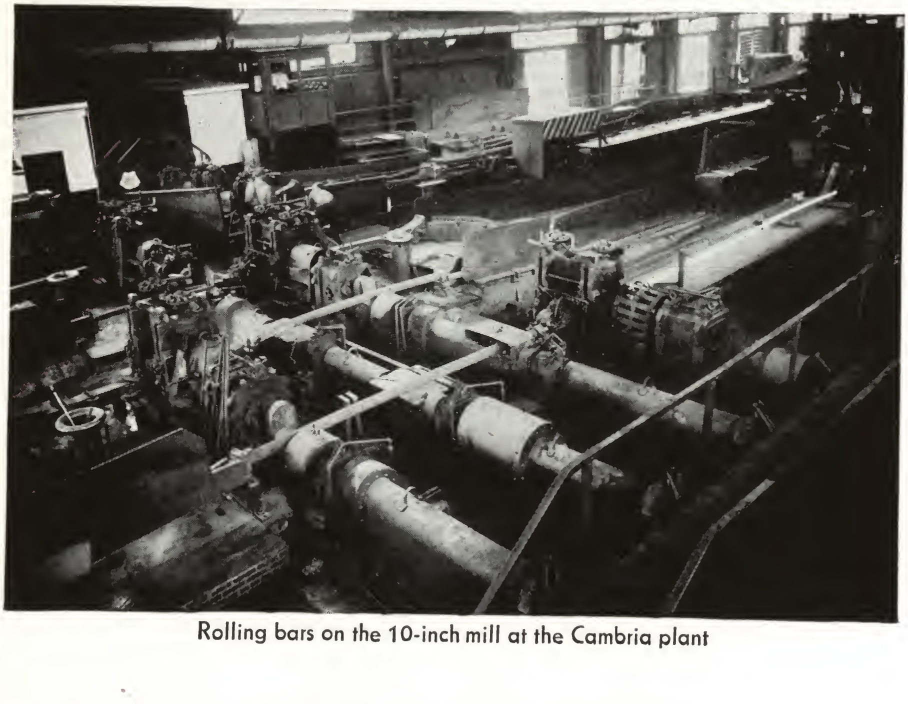
Billet yard, showing charging of reheating furnace at the Cambria plant

Section of roll shop at the Cambria plant

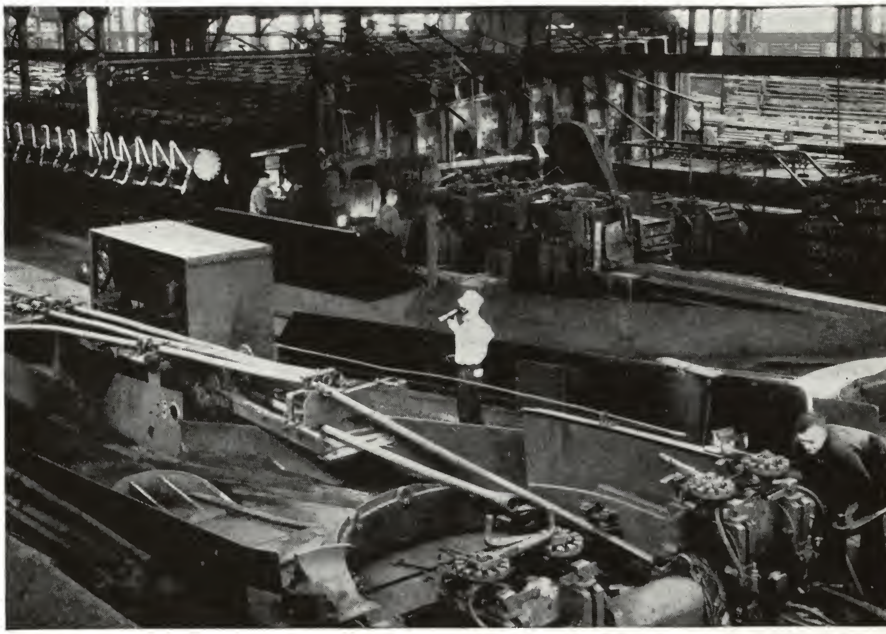
30-inch continuous mill at the Lackawanna plant

Rolling bars on the 14-inch mill at the Lackawanna plant

Rolling bars on the 13-inch mill at the Cambria plant
(Note: Two-zone heating furnaces in background with regulated temperature and atmospheric control)



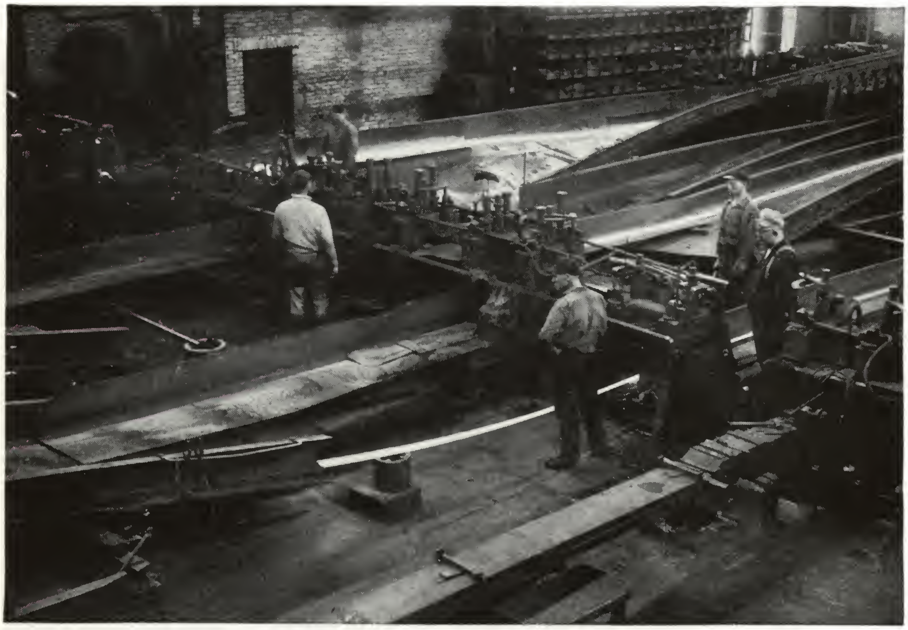
Rolling bars on the 10-inch mill at the Cambria plant



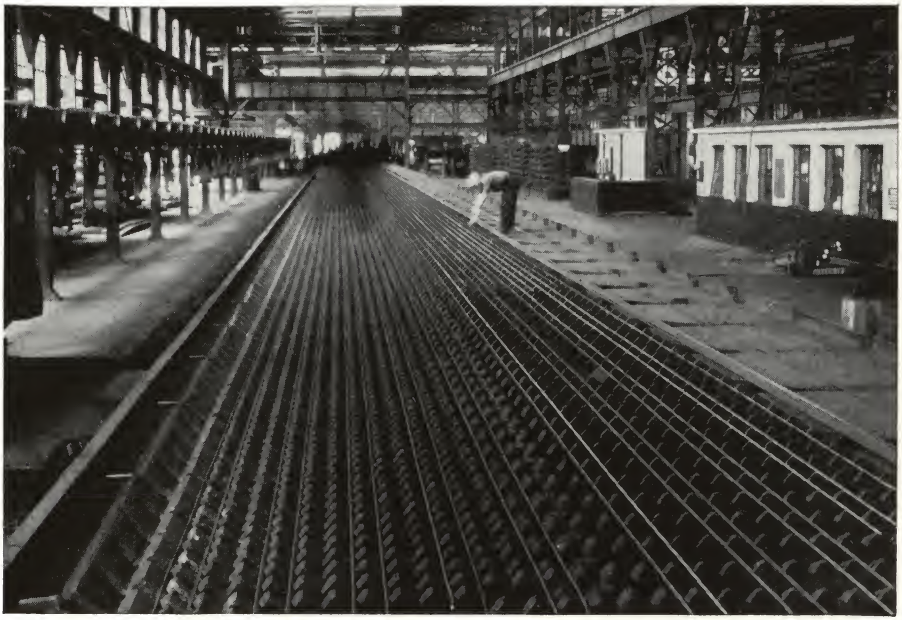
Rolling bars on the 10-inch mill at the Cambria plant. Note the observer taking temperature

Coiling apparatus on the 10-inch mill at the Cambria plant

Rolling bars on the 10-inch mill at the Lackawanna plant



Rolling bars on the 9-inch mill at the Cambria plant



Hot bed of the 10-inch mill at the Cambria plant

Straightening equipment at the Lackawanna plant

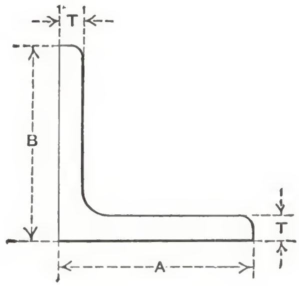
Shipping bay at the Cambria plant

Car loaded with bars ready for shipment

PART I

PROFILES AND LISTS OF CARBON STEEL BARS AND SPECIAL SECTIONS

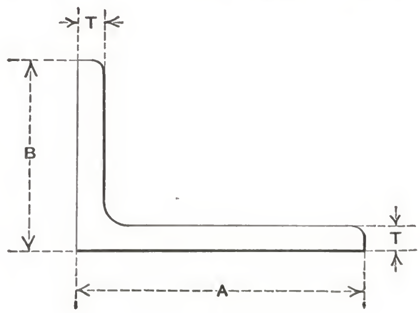
ANGLES—EQUAL LEGS



Section Number	SIZE A x B in.	THICKNESS—T, IN INCHES ⅛	3/16	¼	5/16	⅜	7/16	½
		WEIGHT IN POUNDS PER LINEAR FOOT						
A 77	¾ x ¾	0.59	0.84	1.06	......	......	......	......
A 88	⅞ x ⅞	0.69	1.00	......	......	......	......	......
A 100	1 x 1	0.80	1.16	1.49	......	......	......	......
A 11	1⅛ x 1⅛	0.91	1.32	1.70	......	......	......	......
A 12	1¼ x 1¼	1.01	1.48	1.92	2.33	......	......	......
A 15	1½ x 1½	1.23	1.80	2.34	2.86	3.35	......	......
A 17	1¾ x 1¾	1.44	2.12	2.77	3.39	3.99	4.6	......
A 20	2 x 2	1.65	2.44	3.19	3.92	4.7	5.3	6.0
A 22	2¼ x 2¼	1.86	2.75	3.62	4.5	5.3	6.1	6.8
A 25	2½ x 2½	2.08	3.07	4.1	5.0	5.9	6.8	7.7
A 28	2¾ x 2¾	2.28	3.39	4.5	5.6	6.6	7.6	8.5

Other sizes of angles may be furnished by special arrangement.

ANGLES — UNEQUAL LEGS



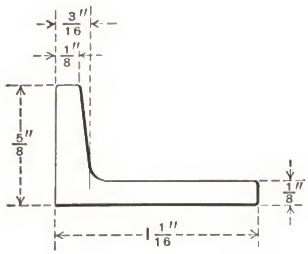
Section Number	SIZE A x B in.	⅛	3/16	¼	5/16	⅜	7/16	½
		THICKNESS — T, IN INCHES — WEIGHT IN POUNDS PER LINEAR FOOT						
A 106	1 x ⅝	0.64	....	....	....	....	....	....
†A 126	1¼ x 11/16	....	....	1.42	....	....	....	....
A 18	1⅜ x ⅞	0.91	1.32	....	....	....	....	....
A 19	1½ x 1	1.02	....	....	....	....	....	....
A 16	1¾ x 1¼	1.23	1.80	2.34	....	....	....	....
A 23	2 x 1¼	....	1.96	2.55	....	....	....	....
A 21	2 x 1½	1.44	2.12	2.77	3.39	3.99	....	....
A 24	2 7/16 x 1 15/16	*1.81	....	....	....	....	....	....
A 26	2½ x 1½	*1.65	2.44	3.19	3.92	....	....	....
A 27	2½ x 2	1.86	2.75	3.62	4.5	5.3	6.1	6.8

*Special gauge taking a special extra.

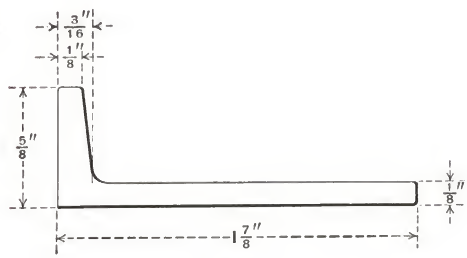
Other sizes of angles may be furnished by special arrangement.

†Rolled only by special arrangement.

ANGLES — SPECIAL

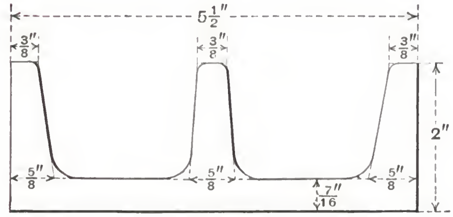


A 116
0.73 Pounds per Foot



A 1
1.07 Pounds per Foot

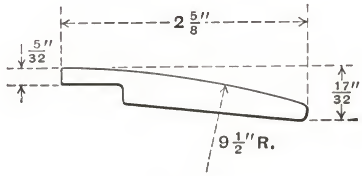
ANTI-CLIMBER SECTION



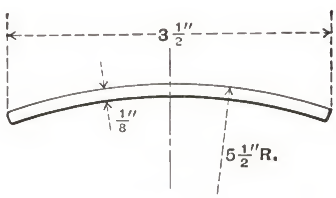
M 1021
16.50 Pounds per Foot
Rolled for
Waugh Equipment Co.

AUTOMOBILE SECTIONS

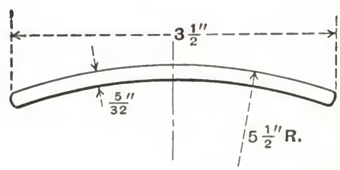
BUMPERS



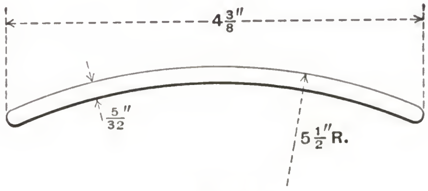
M 1374
2.11 Pounds per Foot
Rolled for
Eaton Mfg. Co.



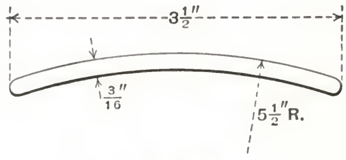
M 1601
1.53 Pounds per Foot



M 1646
1.87 Pounds per Foot



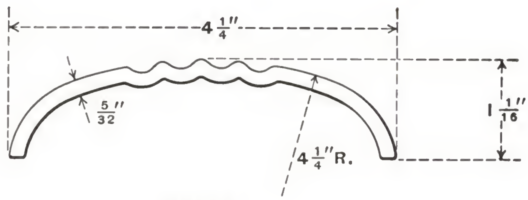
M 1733
2.40 Pounds per Foot
Rolled for
Electric Auto-Lite Co.



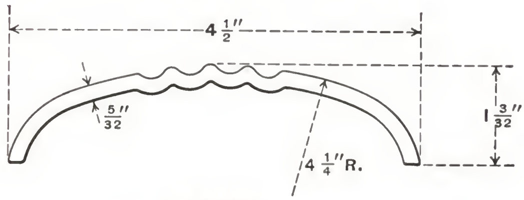
M 1362
2.26 Pounds per Foot

AUTOMOBILE SECTIONS

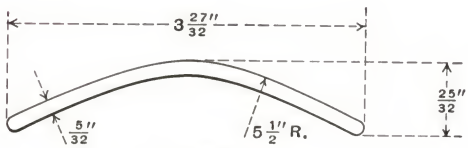
BUMPERS



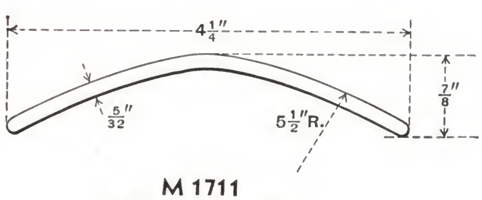
M 1631
2.73 Pounds per Foot
Rolled for
Michigan Bumper Corp.



M 1630
2.86 Pounds per Foot
Rolled for
Michigan Bumper Corp.



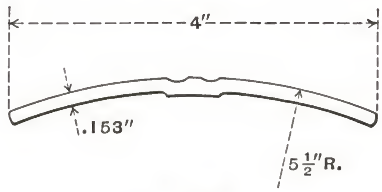
M 1650
2.18 Pounds per Foot
Rolled for
Electric Auto-Lite Co.



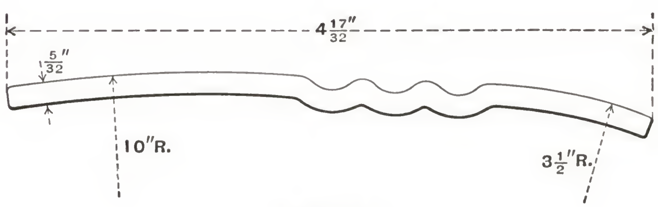
M 1711
2.38 Pounds per Foot
Rolled for
Electric Auto-Lite Co.

AUTOMOBILE SECTIONS

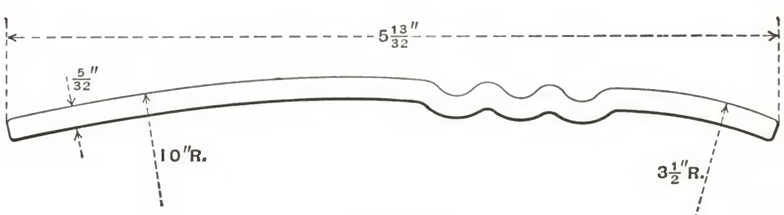
BUMPERS



M 1639
2.18 Pounds per Foot



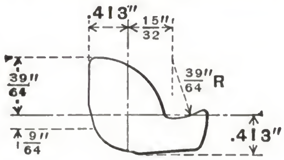
M 1713
2.49 Pounds per Foot
Rolled for
Electric Auto-Lite Co.



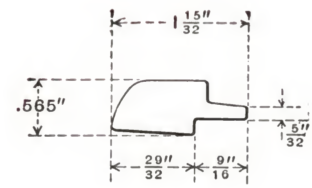
M 1712
2.97 Pounds per Foot
Rolled for
Electric Auto-Lite Co.

AUTOMOBILE SECTIONS

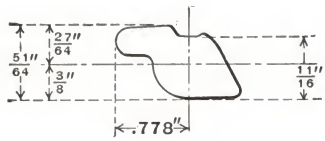
DOOR LATCHES



M 1335
2.73 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.

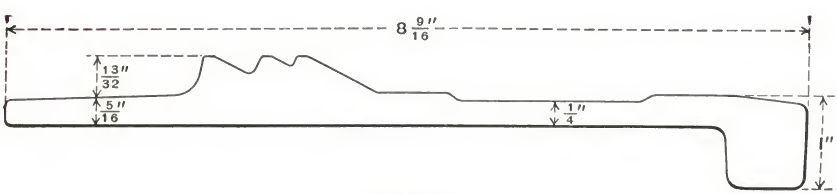


M 1479
1.97 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.



M 1610
2.27 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.

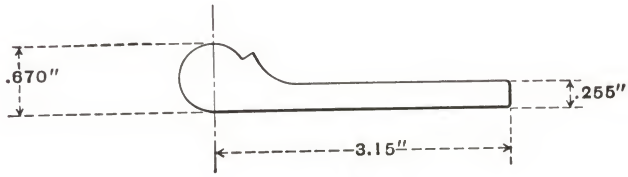
FELLOE BAND



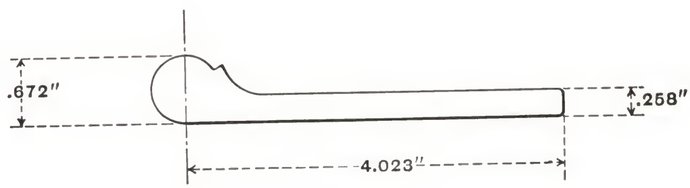
W 435
12.42 Pounds per Foot
Rolled for
Goodyear Tire and Rubber Co.

AUTOMOBILE SECTIONS

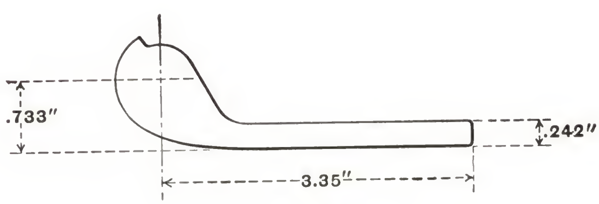
HINGES



M 1212
4.01 Pounds per Foot



M 1213
4.79 Pounds per Foot

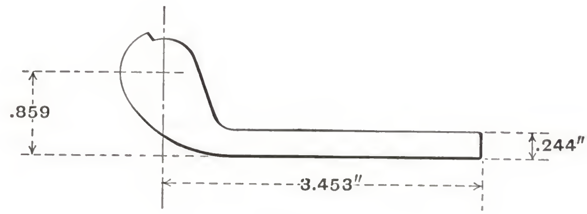


M 1215
5.24 Pounds per Foot

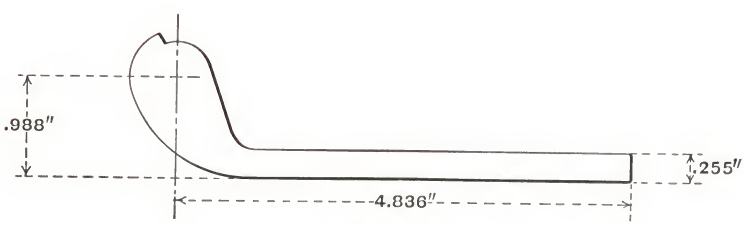
All rolled for Wyckoff Drawn Steel Co.

AUTOMOBILE SECTIONS

HINGES



M 1244
5.47 Pounds per Foot

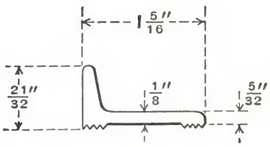


M 1214
7.13 Pounds per Foot

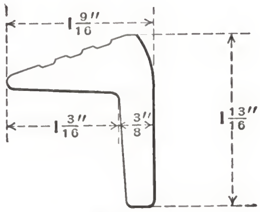
All rolled for Wyckoff Drawn Steel Co.

AUTOMOBILE SECTIONS

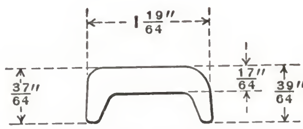
MISCELLANEOUS



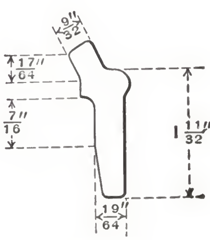
W 388
0.87 Pounds per Foot
Rolled for
Ford Motor Co.



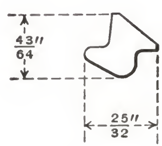
W 364
3.41 Pounds per Foot
Rolled for
GoodyearTire&RubberCo.



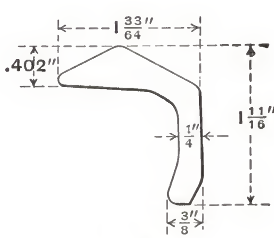
W 410
1.40 Pounds per Foot
Rolled for
Kelsey-Hayes Wheel Co.



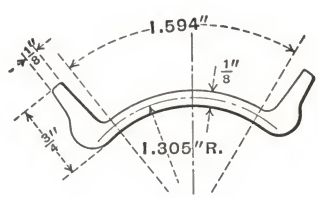
W 412
1.70 Pounds per Foot
Rolled for
Kelsey-Hayes Wheel Co.



W 417
0.85 Pounds per Foot
Rolled for
The Cleveland Welding Co.



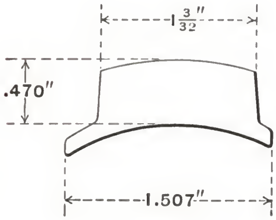
W 427
2.60 Pounds per Foot
Rolled for
Goodyear Tire & Rubber Co.



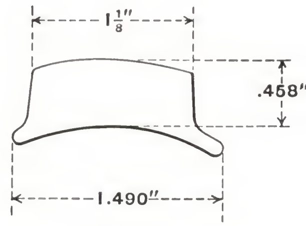
W 434
1.80 Pounds per Foot
Rolled for
Goodyear Tire & Rubber Co.

AUTOMOBILE SECTIONS

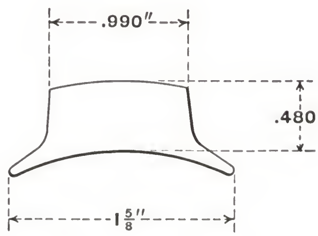
POLE PIECES



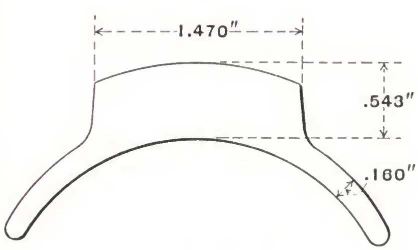
W 436
1.99 Pounds per Foot
Rolled for
Electric Auto-Lite Co.



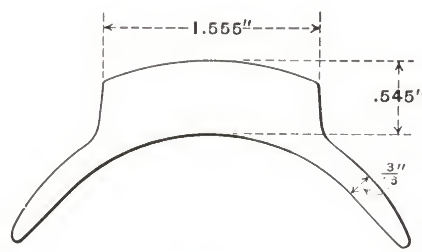
W 428
1.97 Pounds per Foot
Rolled for General Motors Corp.
(Delco-Remy Division)



W 429
1.92 Pounds per Foot
Rolled for
Ford Motor Co.



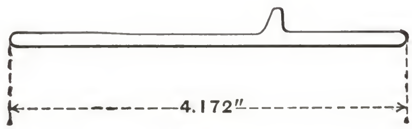
W 438
3.78 Pounds per Foot
Rolled for
Electric Auto-Lite Co.



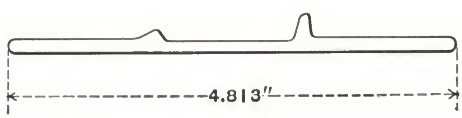
W 383
4.18 Pounds per Foot
Rolled for General Motors Corp.
(Delco-Remy Division)

AUTOMOBILE SECTIONS

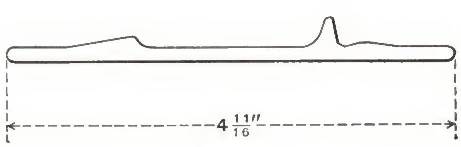
RIMS



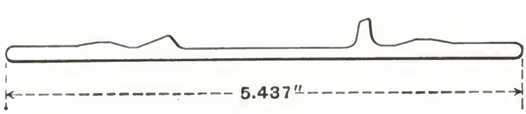
W 431
1.80 Pounds per Foot



W 397
2.13 Pounds per Foot



W 432
2.29 Pounds per Foot

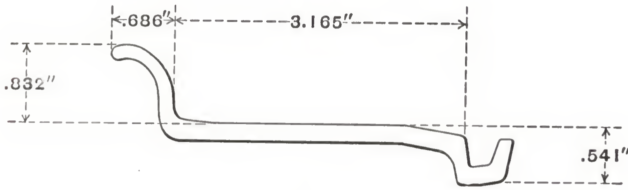


W 405
2.65 Pounds per Foot

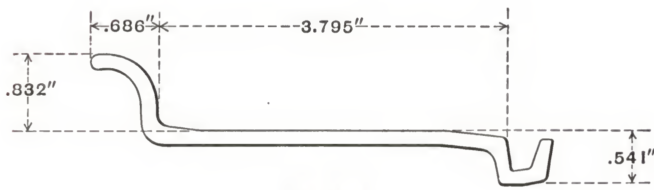
All rolled for Kelsey-Hayes Wheel Co.

AUTOMOBILE SECTIONS

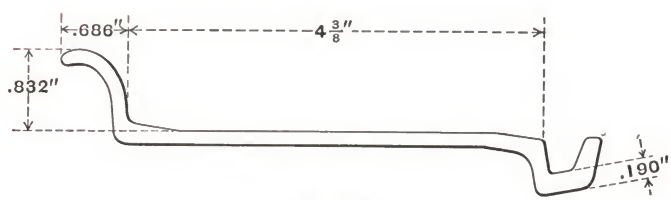
RIMS



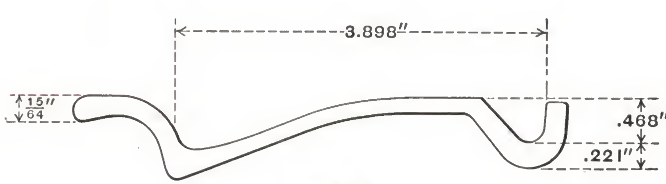
W 370
3.02 Pounds per Foot



W 369
3.34 Pounds per Foot



W 419
3.83 Pounds per Foot

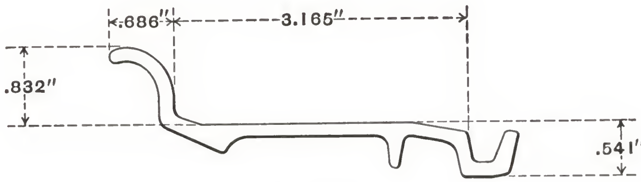


W 433
3.82 Pounds per Foot

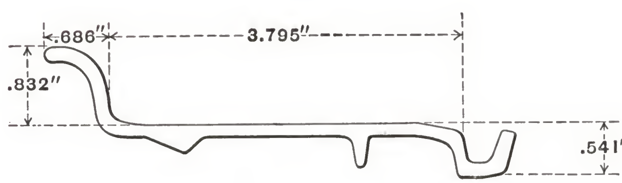
All rolled for Kelsey-Hayes Wheel Co.

AUTOMOBILE SECTIONS

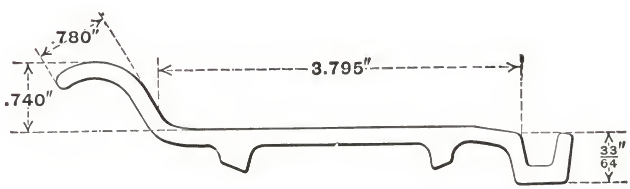
RIMS



W 374
3.04 Pounds per Foot



W 379
3.25 Pounds per Foot

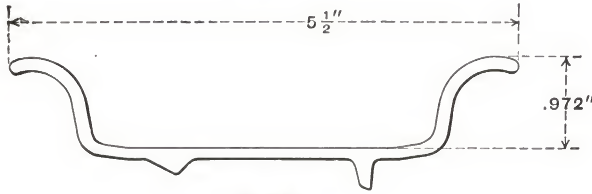


W 344
4.08 Pounds per Foot

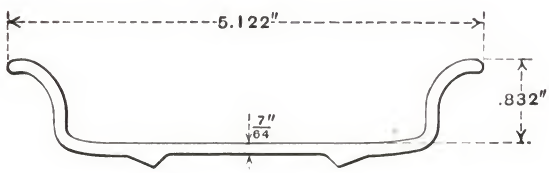
All rolled for Kelsey-Hayes Wheel Co.

AUTOMOBILE SECTIONS

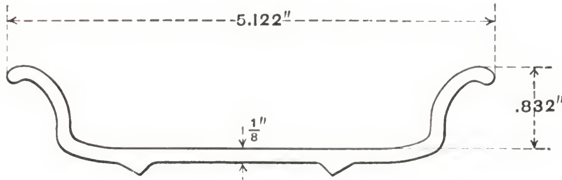
RIMS



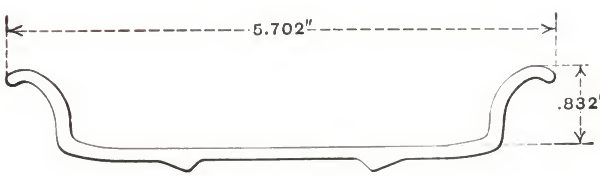
W 350
3.40 Pounds per Foot



W 292
2.90 Pounds per Foot



W 280
3.16 Pounds per Foot

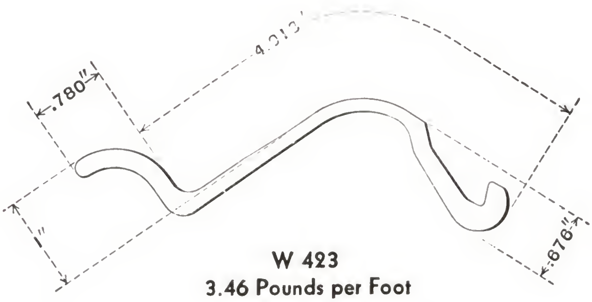


W 294
3.19 Pounds per Foot

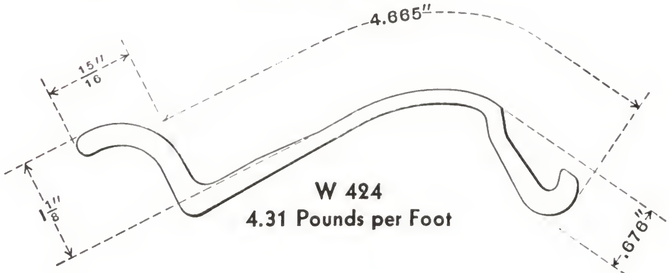
All rolled for Kelsey-Hayes Wheel Co.

AUTOMOBILE SECTIONS

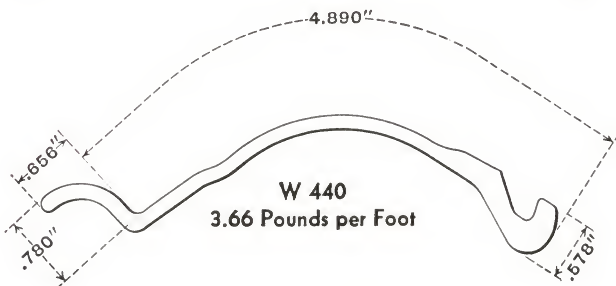
RIMS



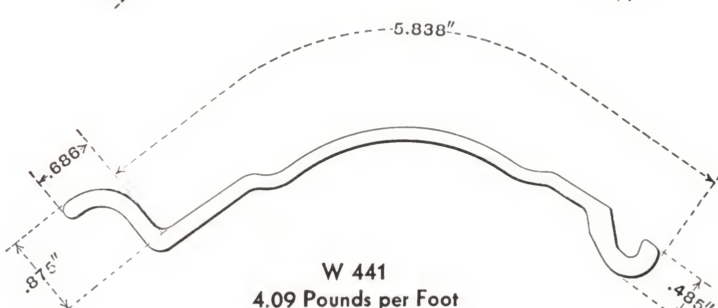
W 423
3.46 Pounds per Foot



W 424
4.31 Pounds per Foot



W 440
3.66 Pounds per Foot

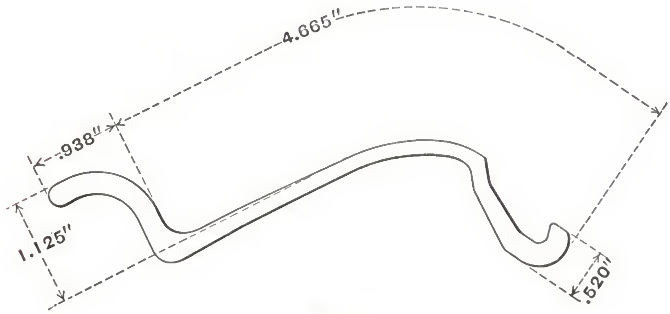


W 441
4.09 Pounds per Foot

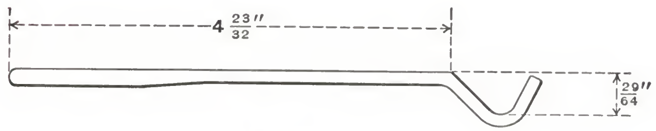
All rolled for Goodyear Tire & Rubber Co.

AUTOMOBILE SECTIONS

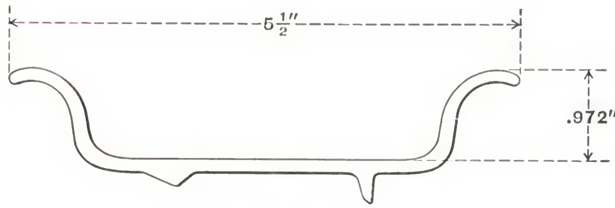
RIMS



W 443
4.31 Pounds per Foot
Rolled for
Budd Wheel Co.



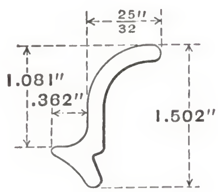
W 296
2.97 Pounds per Foot
Rolled for
The Cleveland Welding Co.



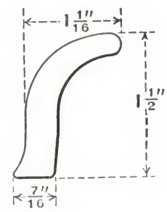
W 430
3.40 Pounds per Foot
Rolled for
American Welding & Mfg. Co.

AUTOMOBILE SECTIONS

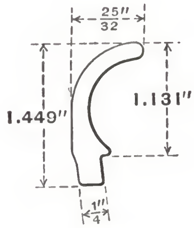
SIDE RINGS



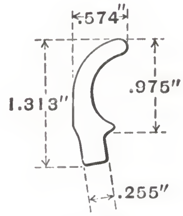
W 299
1.32 Pounds per Foot
Rolled for
Kelsey-Hayes Wheel Co.



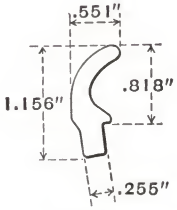
W 418
2.07 Pounds per Foot
Rolled for
The Cleveland Welding Co.



W 327
1.28 Pounds per Foot
Rolled for
Kelsey-Hayes Wheel Co.



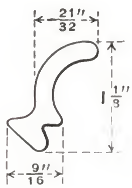
W 372
1.17 Pounds per Foot
Rolled for
Kelsey-Hayes Wheel Co.



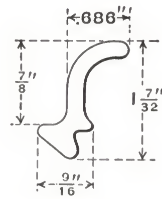
W 373
1.03 Pounds per Foot
Rolled for
Kelsey-Hayes Wheel Co.

AUTOMOBILE SECTIONS

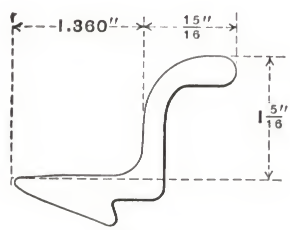
SIDE RINGS



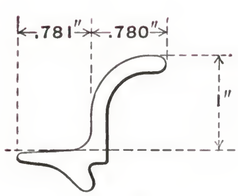
W 439
1.02 Pounds per Foot



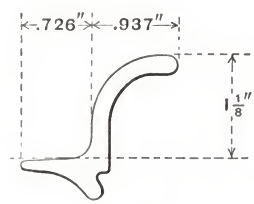
W 442
1.17 Pounds per Foot



W 360
2.86 Pounds per Foot



W 426
1.53 Pounds per Foot

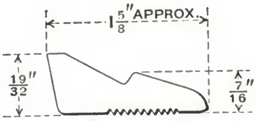


W 425
1.73 Pounds per Foot

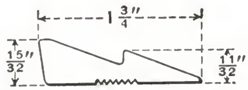
All rolled for Goodyear Tire & Rubber Co.

AUTOMOBILE SECTIONS

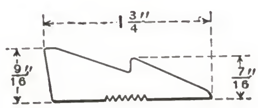
STRIKER PLATES



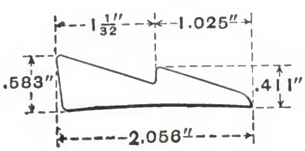
M 1344
1.96 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.



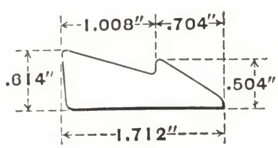
M 1354
1.60 Pounds per Foot
Rolled for
Ford Motor Co.



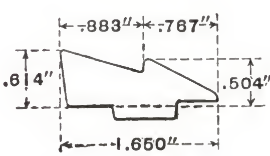
M 1483
2.00 Pounds per Foot
Rolled for
Ford Motor Co.



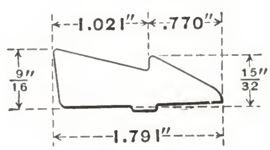
M 1506
2.22 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.



M 1587
2.34 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.



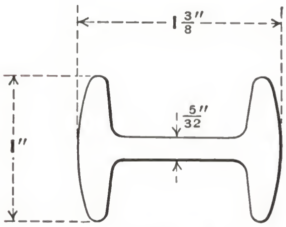
M 1588
2.53 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.



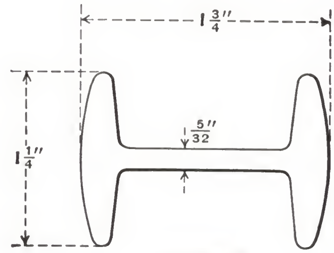
M 1619
2.30 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.

BEAM SECTIONS

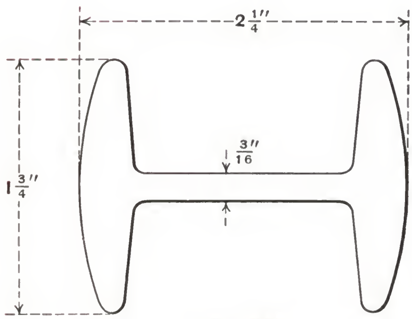
FENCE



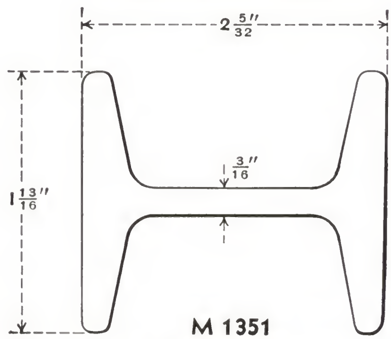
M 1253
1.75 Pounds per Foot
Rolled for
The Stewart Iron Works Co.



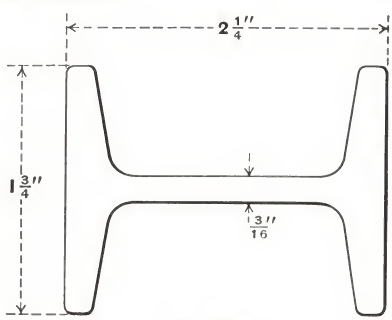
M 1254
2.37 Pounds per Foot
Rolled for
The Stewart Iron Works Co.



M 1255
4.23 Pounds per Foot
Rolled for
The Stewart Iron Works Co.



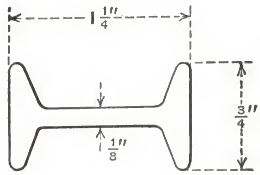
M 1351
4.37 Pounds per Foot
Rolled for
Continental Steel Corp.
(Branded)



M 1603
4.18 Pounds per Foot
Rolled for
W. F. Robertson Steel & Iron Co.
(Branded)

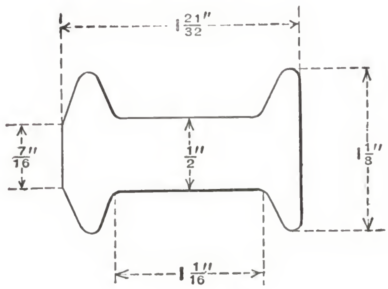
BEAM SECTIONS

BARREL



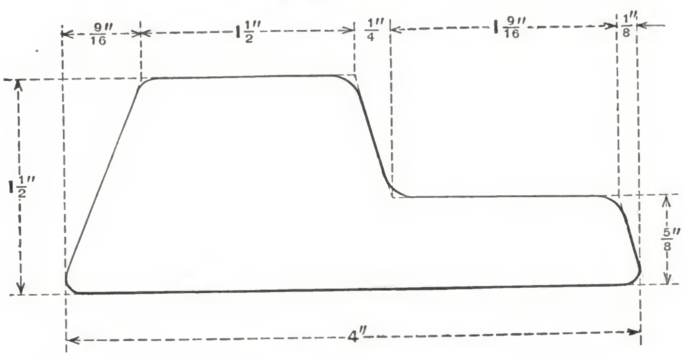
M 1037
1.10 Pounds per Foot

SPECIAL



M 1054
3.63 Pounds per Foot
Rolled for
Wagner Mfg. Co.

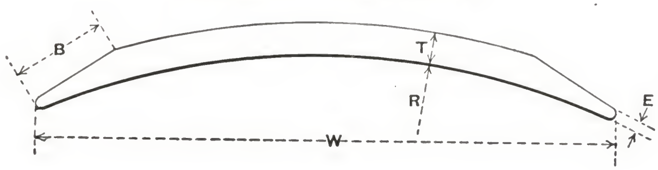
BELT RAIL



L 1
13.5 Pounds per Foot

BEVELS

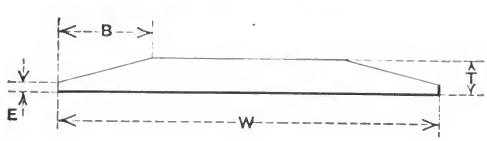
DOUBLE — CONCAVE



Section Number	DIMENSIONS IN INCHES					Pounds per Foot
	W	T	B	E	R	
*M 1580	5 29/32	31/64	1	.086	11	8.74
*M 1581	5 29/32	5/8	1 1/4	.086	10.185	10.80
*M 1074	6	5/16	1	.086	7.50	5.85
*M 1620	6	5/16	1	.086	11	5.65
*M 1652	6	5/16	1	.086	11	5.65
*M 1075	6	3/8	1	.086	12.50	6.96
*M 1621	6	3/8	1	.086	11	6.75
*M 1653	6	3/8	1	.086	11	6.75
*M 1076	6	1/2	1 1/8	.086	12.50	9.00
M 1589	6	1/2	1 1/8	.086	7.50	9.15
M 1590	6	5/8	1 7/32	.086	7.50	11.36
*M 1077	6	5/8	1 1/4	.086	12.50	11.00
M 1594	8	1/2	1	3/32	11	12.65
*M 1637	8	1/2	1	3/32	11	12.65
M 1595	8	5/8	1 1/4	3/32	11	15.44

*These sections were branded by special arrangement.

DOUBLE—PLAIN

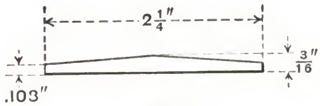


Section Number	DIMENSIONS IN INCHES				Pounds per Foot
	W	T	B	E	
M 207	7/8	No. 12 .109	1/8	abt. 3/64	0.298
M 1608	2 5/8	3/16	.108	abt. 1/32	1.61
M 1647	2 5/8	3/16	.108	abt. 1/32	1.61
M 1636	3 1/2	3/16	1 1/4	.072	1.74
*M 795	6	5/16	1	.083	5.53
*M 796	6	3/8	1	.083	6.59
*M 797	6	1/2	1	.083	8.71
*M 798	6	5/8	1 1/4	.083	10.36

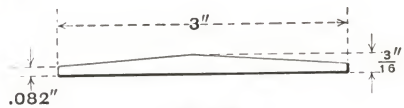
*These sections were branded by special arrangement.

BEVELS

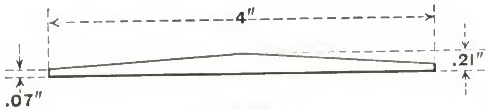
DOUBLE



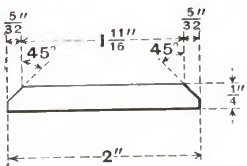
M 177
1.13 Pounds per Foot



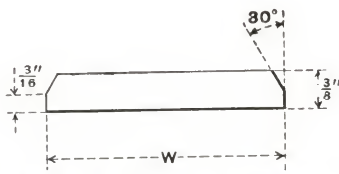
M 188
1.37 Pounds per Foot



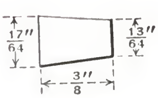
M 194
1.90 Pounds per Foot



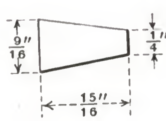
M 1670
1.62 Pounds per Foot



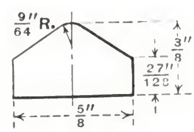
M 1648, W=2½", 3.13 Pounds per Foot
M 1655, W=3", 3.77 Pounds per Foot



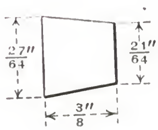
M 146
0.29 Pounds per Foot



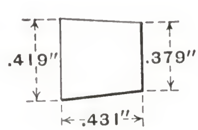
M 944
1.29 Pounds per Foot



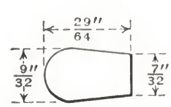
M 765
0.64 Pounds per Foot



M 148
0.48 Pounds per Foot



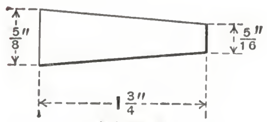
M 1570
0.58 Pounds per Foot



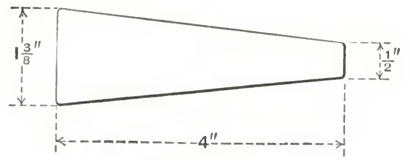
M 1511
0.36 Pounds per Foot

BEVELS

DOUBLE

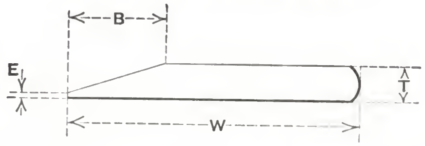


M 946
2.79 Pounds per Foot



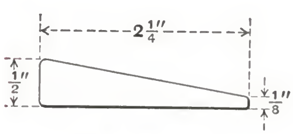
M 1753
12.75 Pounds per Foot

SINGLE BEVEL EDGE

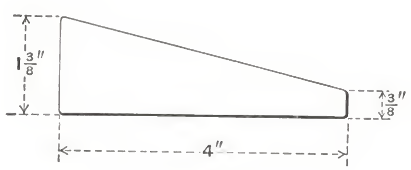


Section Number	DIMENSIONS IN INCHES				Pounds per Foot
	W	T	B	E	
*M 1585	1 25/32	5/16	11/32	1/32	1.67
°*M 1592	1 13/16	11/16	25/32	7/32	3.62
†M 794	2	1/4	1	1/16	1.40
*M 1499	2 1/2	0.140	1/4	1/32	1.15
M 1107	2 1/2	1/4	1	1/16	1.79
M 449	3	5/16	2	1/16	2.29

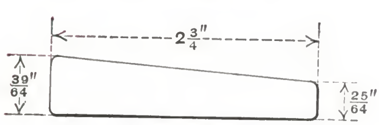
*Thick edge is square. †Section was branded by special arrangement.
°Rolled only by special arrangement.



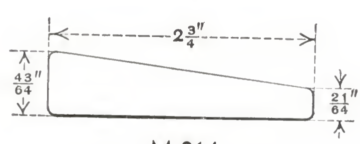
M 1629
2.39 Pounds per Foot



M 1752
11.90 Pounds per Foot

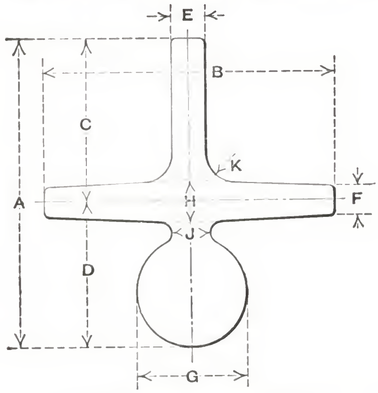


M 813
4.67 Pounds per Foot



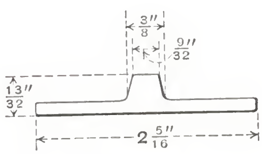
M 814
4.67 Pounds per Foot

BRAKE BEAMS (DAVIS)

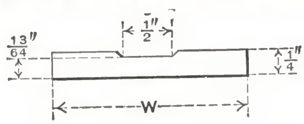


Section Number	DIMENSIONS IN INCHES										Pounds per Foot
	A	B	C	D	E	F	G	H	J	K	
M 484	$3\frac{3}{16}$	3	$1\frac{11}{16}$	$1\frac{1}{2}$	$\frac{3}{8}$	$\frac{5}{16}$	$1\frac{1}{8}$	$\frac{7}{16}$	$\frac{13}{32}$	$\frac{1}{4}$	9.41
M 485	$3\frac{3}{8}$	3	$1\frac{11}{16}$	$1\frac{11}{16}$	$\frac{1}{2}$	$\frac{3}{8}$	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{1}{2}$	$\frac{5}{16}$	12.02
M 486	$3\frac{3}{4}$	$3\frac{3}{4}$	$1\frac{3}{4}$	2	$\frac{5}{8}$	$\frac{1}{2}$	$1\frac{1}{2}$	$\frac{3}{4}$	$\frac{5}{8}$	$\frac{5}{16}$	17.39

CAN RING SECTIONS

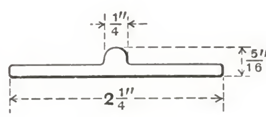


M 1607
1.36 Pounds per Foot



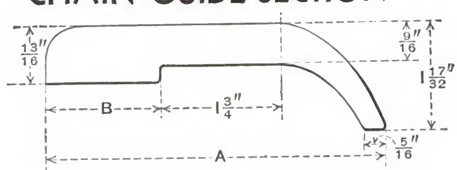
Section Number	W in.	Pounds per Foot
M 1016	$1\frac{1}{4}$	0.94
M 1017	$1\frac{1}{2}$	1.15
M 1018	2	1.57

Rolled for
York Ice Machinery Corp.



M 1681
1.09 Pounds per Foot

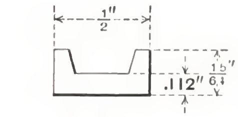
CHAIN GUIDE SECTION



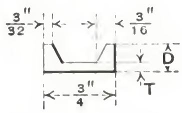
Section Number	A in.	B in.	Pounds per Foot
M 519	$4\frac{5}{8}$	$1\frac{3}{8}$	9.75
M 592	$4\frac{7}{8}$	$1\frac{5}{8}$	10.52

Rolled for
Goodman Mfg. Co.

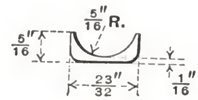
CHANNELS



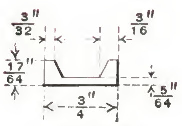
SC 375
0.26 Pounds per Foot



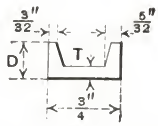
Section Number	D in.	T in.	Pounds per Foot
SC 325	19/64	7/64	0.46
SC 325	5/16	1/8	0.50



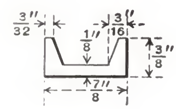
SC 367
0.36 Pounds per Foot



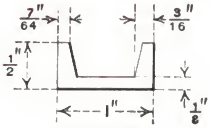
SC 324
0.38 Pounds per Foot



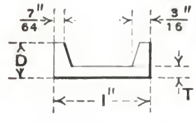
Section Number	D in.	T in.	Pounds per Foot
SC 357	11/32	3/32	0.46
SC 357	3/8	1/8	0.54



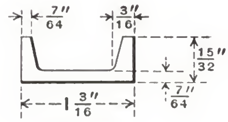
SC 384
0.61 Pounds per Foot



SC 328
0.80 Pounds per Foot

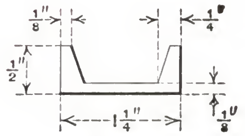


Section Number	D in.	T in.	Pounds per Foot
SC 326	11/32	3/32	0.58
SC 326	3/8	1/8	0.68
SC 326	13/32	5/32	0.78

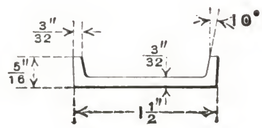


SC 379
0.81 Pounds per Foot

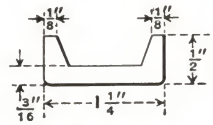
CHANNELS



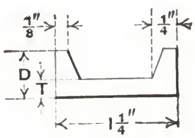
SC 354
1.00 Pound per Foot



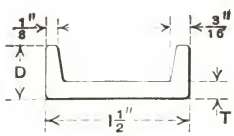
SC 373
0.66 Pounds per Foot



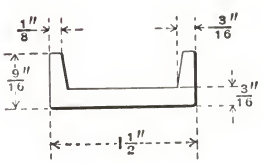
SC 378
1.19 Pounds per Foot



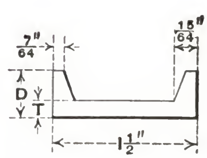
Section Number	D in.	T in.	Pounds per Foot
SC 331	7/16	1/8	0.93
SC 331	1/2	3/16	1.19
SC 331	9/16	1/4	1.45



Section Number	D in.	T in.	Pounds per Foot
SC 362	1/2	1/8	1.04
SC 362	9/16	3/16	1.36

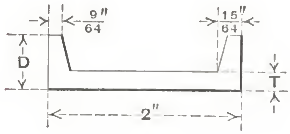


SC 401
1.36 Pounds per Foot

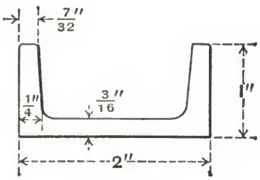


Section Number	D in.	T in.	Pounds per Foot
SC 334	7/16	1/8	1.00
SC 334	1/2	3/16	1.32

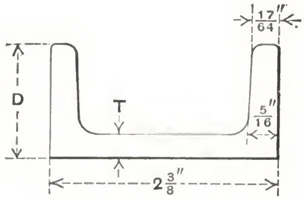
CHANNELS



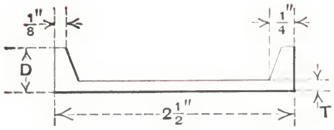
Section Number	D in.	T in.	Pounds per Foot
SC 361	1/2	1/8	1.34
SC 361	9/16	3/16	1.76
SC 361	5/8	1/4	2.18



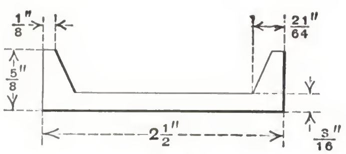
SC 399
2.59 Pounds per Foot



Section Number	D in.	T in.	Pounds per Foot
SC 24	1 3/16	1/4	3.87
SC 24	1 1/4	5/16	4.37

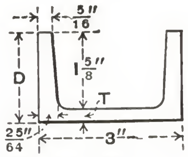


Section Number	D in.	T in.	Pounds per Foot
SC 343	15/32	1/8	1.52
SC 343	1/2	5/32	1.78
SC 343	33/64	11/64	1.92

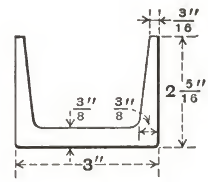


SC 344
2.27 Pounds per Foot

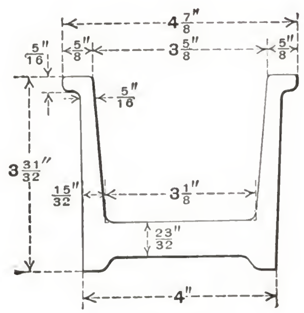
CHANNELS



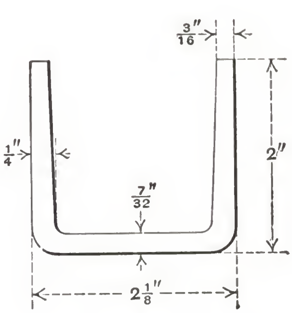
Section Number	D in.	T in.	Pounds per Foot
SC 3	1 7/8	1/4	6.5
SC 3	1 15/16	5/16	7.1
SC 3	2 1/8	1/2	9.0
SC 3	2 1/4	5/8	10.3



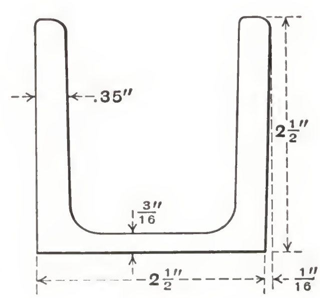
SC 3 a
7.62 Pounds per Foot



SC 359
19.12 Pounds per Foot



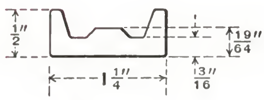
SC 369
4.25 Pounds per Foot



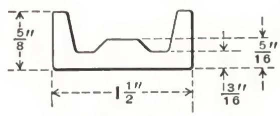
SC 25
7.20 Pounds per Foot

CHANNELS

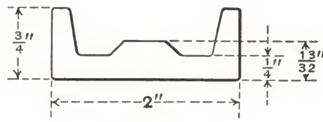
FENCE



SC 346
1.31 Pounds per Foot

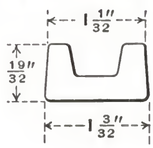


SC 347
1.73 Pounds per Foot



SC 348
2.82 Pounds per Foot

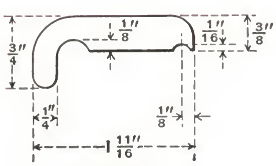
RAIL ANCHOR SECTION



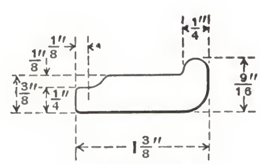
SC 374
1.56 Pounds per Foot

CLAMP SECTIONS

SUSPENSION

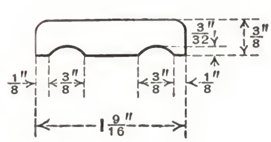


M 1317
2.12 Pounds per Foot

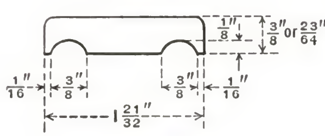


M 1318
1.74 Pounds per Foot

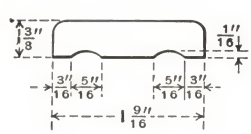
GUY



M 1099
1.77 Pounds per Foot

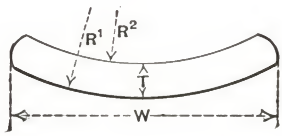


M 1008
1.78 Pounds per Foot for 23/64" Thick
1.89 Pounds per Foot for 3/8" Thick



M 1316
1.77 Pounds per Foot

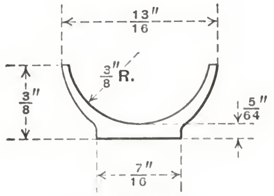
CONCAVE-CONVEX SLEIGH SHOE SECTION



Section Number	DIMENSIONS IN INCHES W	T	R^1	R^2	Pounds per Foot
M 58	2	5/16	3	2 5/8	2.11
M 59	2	3/8	3	2 5/8	2.50
M 60	2	7/16	3	2 5/8	2.90
M 61	2	1/2	3	2 5/8	3.30
M 1379	2 1/4	3/8	3	2 5/8	2.83
M 64	2 1/2	5/16	3	2 5/8	2.68
M 65	2 1/2	3/8	3	2 5/8	3.18
M 66	2 1/2	7/16	3	2 5/8	3.67
M 67	2 1/2	1/2	3	2 5/8	4.17
M 69	3	5/16	3	2 5/8	3.29
M 70	3	3/8	3	2 5/8	3.88
M 71	3	7/16	3	2 5/8	4.48
M 72	3	1/2	3	2 5/8	5.06
M 1378	3	5/8	3	2 5/8	6.22
M 73	3 1/2	5/16	3	2 5/8	3.95
M 74	3 1/2	3/8	3	2 5/8	4.63
M 75	3 1/2	7/16	3	2 5/8	5.32
M 76	3 1/2	1/2	3	2 5/8	5.99
M 77	3 1/2	9/16	3	2 5/8	6.66
M 78	4	5/16	3	2 5/8	4.63
M 79	4	3/8	3	2 5/8	5.41
M 80	4	7/16	3	2 5/8	6.18
M 81	4	1/2	3	2 5/8	6.95
M 82	4	9/16	3	2 5/8	7.73
M 1380	4	5/8	3	2 5/8	8.50
M 1381	4	3/4	3	2 5/8	10.04

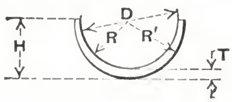
CRESCENTS

FLAT BASE



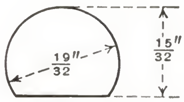
M 1554
0.28 Pounds per Foot

CRESCENTS (STANDARD)

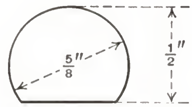


Section Number	SIZE D	DIMENSIONS IN INCHES			THICKNESS — T (B.W.G.)					
					15 Ga.	14 Ga.	13 Ga.	12 Ga.	11 Ga.	10 Ga.
	in.	H	R	R′	WEIGHT IN POUNDS PER LINEAR FOOT					
M 98	11/32	15/64	11/64	13/64	. . .	.130	.144	.159	. . .	. . .
M 1541	11/32	17/64	11/64	13/64	. . .	.136	.153	.168	. . .	. . .
M 97	3/8	1/4	3/16	7/32	. . .	.141	.155	.173	.186	. . .
M 96	3/8	9/32	3/16	7/32	. . .	.147	.158	.176	.190	. . .
M 91	1/2	1/4	1/4	9/32	.149	.167	.187	.208	. . .	. . .
M 744	1/2	9/32	1/4	9/32	.158	.177	.196	.219	.236	. . .
M 90	1/2	5/16	1/4	9/32	. . .	.183	.203	.227	.245	. . .
M 742	5/8	5/16	5/16	21/64	. . .	.194	.218	.245	. . .	. . .
M 733	5/8	11/32	5/16	21/64	. . .	.196	.221	.249	. . .	. . .
M 88	5/8	19/64	5/16	11/32	. . .	.207	.231	.257	. . .	. . .
M 740	5/8	5/16	5/16	11/32	. . .	.211	.235	.262	. . .	. . .
M 87	5/8	11/32	5/16	11/32	. . .	.218	.244	.273	. . .	. . .
M 86	5/8	25/64	5/16	11/32	. . .	.230	.255	.282	. . .	. . .
M 85	3/4	23/64	3/8	13/32	. . .	.250	.282	.313	. . .	. . .
M 721	3/4	3/8	3/8	13/32	. . .	.255	.286	.320	.347	. . .
M 737	3/4	25/64	3/8	13/32	. . .	.259	.289	.323	.350	. . .
M 84	3/4	13/32	3/8	13/32	. . .	.262	.292	.330	.354	. . .
M 83	3/4	29/64	3/8	13/32	. . .	.272	.303	.340	.368	. . .
M 1110	7/8	13/32	7/16	15/32	. . .	.288	.323	.362	. . .	.425
M 1591	1	1/2	1/2	35/64	. . .	.340	.400	.460	. . .	. . .

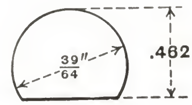
"D" SECTIONS



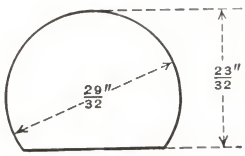
M 1613
0.81 Pounds per Foot



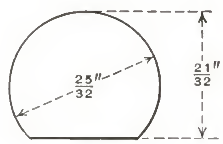
M 1236
0.89 Pounds per Foot



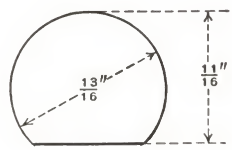
M 1516
0.81 Pounds per Foot



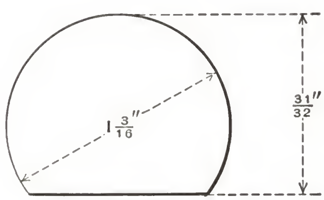
M 1612
1.88 Pounds per Foot



M 1615
1.46 Pounds per Foot

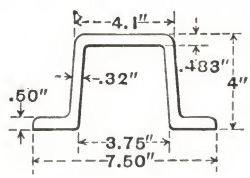


M 1280
1.59 Pounds per Foot



M 1720
3.29 Pounds per Foot

DOOR SPREADER



SC 75
19.8 Pounds per Foot

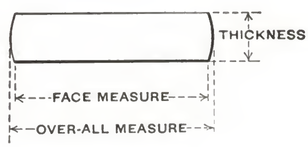
EDGE DEFINITIONS

FLATS

SQUARE EDGE

A Square Edge Flat has practically square edges. The corners may vary from sharp to slightly rounded. The heavier gauge usually has the larger rounding.

ROUND EDGE



Round Edge Plain Flats are round edge flats rolled to the overall dimension for the width. Both edges are rounded to radii determined by various increments specified in the table on page 73.

TIRE EDGE

Tire Edge Flats are the same as round edge plain flats, except that the Face Measurement is specified for the width.

ROUND EDGE CONCAVE

Round Edge Concave Flats are rolled with certain established concavities in the faces and with both edges rounded to the Round Edge Flat Radii.

EDGE DEFINITIONS

FLATS

ROUND EDGE TOE CALK

Round Edge Toe Calk steel applies to some narrow widths of special Round Edge Flats which have larger radii on the edges than are applied to Round Edge Plain or Tire Edge Flats.

FULL ROUND EDGE

Full Round Edge Flats are flats with both edges rounded to a radius equal to ½ the thickness.

ROUND CORNER

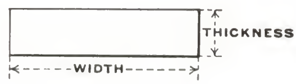
Round Corner Flats are Square Edge Flats with the corners rounded to some specified radius.

BAND EDGE

Band Edges are edges varying anywhere from an approximate square edge to an approximate round edge.

FLATS

SQUARE EDGE



	1/4″ to 1″	wide x 3/16″ to 7/8″	thick
over 1″	to 2″	wide x 3/16″ to 1 3/4″	thick
over 2″	to 3 1/2″	wide x 3/16″ to 2 1/2″	thick
over 3 1/2″	to 6″	wide x 3/16″ to 3″	thick

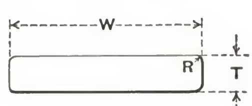
Other sizes may be furnished by special arrangement.

For weights, see tables on pages 315 to 328

NUT STEEL

Nut Steel Flats can be furnished within the range of Square Edge Flats.

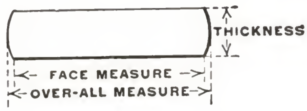
ROUND CORNERED



Section Number	DIMENSIONS IN INCHES W	T	R	Pounds per Foot	Section Number	DIMENSIONS IN INCHES W	T	R	Pounds per Foot
M 882	.883	.365	1/32	1.09	M 1509	1 11/16	1	3/8	5.33
M 1193	.943	.365	1/32	1.17	M 1540	2	1 1/8	1/8	7.60
M 1746	1	1/4	1/16	0.84	M 1709	2 1/4	1 15/16	1/8	14.78
M 1568	1 1/8	19/64	1/16	1.12	M 1549	2 1/2	5/8	1/8	5.27
M 1276	1 1/4	1/4	1/16	1.05	M 884	2 3/4	1/4	3/32	2.31
M 1776	1 1/4	5/16	1/16	1.32	M 885	2 3/4	5/16	3/32	2.90
M 1682	1 1/4	7/8	1/16	3.70	M 886	3 1/4	5/16	3/32	3.43
M 1719	1.256	1.006	1/8	4.25	M 1743	3 1/2	2.009	3/16	23.80
M 1532	1 5/8	15/16	1/8	5.13	M 1661	4 1/2	3	1/8	45.86

FLATS

ROUND EDGE, INCLUDING ROUND EDGE TIRE



3/8" to 7/16" wide x 3/16" to 1/4" thick
1/2" to 9/16" wide x 3/16" to 5/16" thick
5/8" to 11/16" wide x 3/16" to 3/8" thick
3/4" to 13/16" wide x 3/16" to 1/2" thick
7/8" to 1" wide x 3/16" to 3/4" thick
over 1" to 1 7/16" wide x 3/16" to 7/8" thick
over 1 1/2" to 2 1/2" wide x 3/16" to 1 3/8" thick
over 2 1/2" to 3 1/2" wide x 3/16" to 1" thick
over 3 1/2" to 6" wide x 3/16" to 1 3/4" thick

The above sizes can be furnished Face or Over-all Measure.
Sizes not listed, and other roundings will be considered.
For weights, see table on pages 331–340

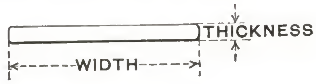
The Over-all Measure is determined by adding to the Face Measure the increments shown below for the corresponding thicknesses.

Thickness Inches	Increment Inches	Edge Radii Inches	Thickness Inches	Increment Inches	Edge Radii Inches	Thickness Inches	Increment Inches	Edge Radii Inches
1/8	1/16	.078	11/16	5/16	.456	1 1/4	7/16	1.002
3/16	3/32	.117	3/4	5/16	.528	1 5/16	1/2	.986
1/4	1/8	.156	13/16	3/8	.534	1 3/8	1/2	1.070
5/16	5/32	.195	7/8	3/8	.604	1 7/16	1/2	1.155
3/8	3/16	.234	15/16	3/8	679	1 1/2	1/2	1.250
7/16	7/32	.273	1	3/8	.760	1 9/16	9/16	1.225
1/2	1/4	.313	1 1/16	7/16	.753	1 5/8	9/16	1.314
9/16	5/16	.331	1 1/8	7/16	.832	1 11/16	9/16	1.406
5/8	5/16	.391	1 3/16	7/16	.915	1 3/4	9/16	1.502

SPRING STEEL

Flat Spring Steel can be furnished within the range of Round Edge Flats.

HOT ROLLED STRIP

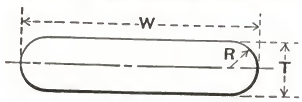


1/4" to 5/16" wide x 3/16" thick
3/8" to 1/2" wide x No. 11 B.W.G. to 3/16" thick
1/2" to 2 1/4" wide x No. 13 B.W.G. to 3/16" thick
2 5/16" to 3" wide x No. 12 B.W.G. to 3/16" thick
3 1/16" to 3 1/2" wide x No. 11 B.W.G. to 3/16" thick
3 9/16" to 6" wide x 3/16" thick

Sizes not listed may be furnished by special arrangement.

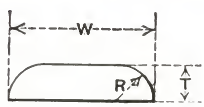
FLATS

FULL ROUND EDGE



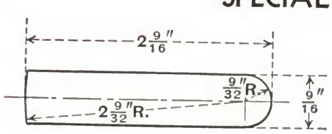
Section Number	DIMENSIONS IN INCHES			Pounds per Foot	Section Number	DIMENSIONS IN INCHES			Pounds per Foot
	W	T	R			W	T	R	
M 1504	3/4	3/16	3/32	0.45	M 982	5	1 1/8	9/16	18.20
M 1665	1 1/8	3/16	3/32	0.69	M 1662	5	1 1/4	5/8	20.11
M 1666	1 1/8	1/4	1/8	0.91	M 1663	5	1 3/8	11/16	21.99
M 1382	1 1/4	5/8	5/16	2.37	M 983	6	1 1/2	3/4	28.95

ROUND BEVEL EDGE

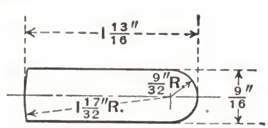


Section Number	DIMENSIONS IN INCHES			Pounds per Foot
	W	T	R	
M 27	3/4	3/16	3/16	0.43
M 951	13/16	3/16	3/16	0.47
M 33	1	1/4	1/4	0.75
M 1692	1 1/4	5/16	5/16	1.18
M 819	1 1/2	3/8	23/64	1.72

SPECIAL ROUND EDGE



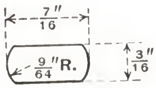
M 1303
4.78 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.



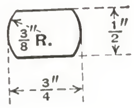
M 1304
3.31 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.

FLATS

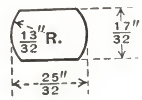
SPECIAL ROUND EDGE



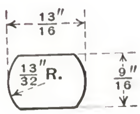
M 1569
0.27 Pounds per Foot



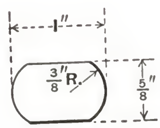
M 1699
1.15 Pounds per Foot



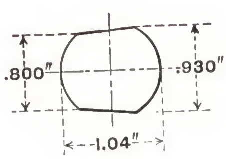
M 1611
1.29 Pounds per Foot



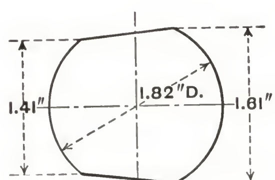
M 1514
1.43 Pounds per Foot



M 956
1.91 Pounds per Foot



M 1668
2.70 Pounds per Foot
Rolled for
American Locomotive Co.



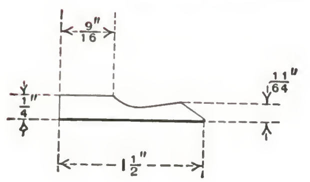
M 1667
8.21 Pounds per Foot
Rolled for
American Locomotive Co.

HEXAGONS

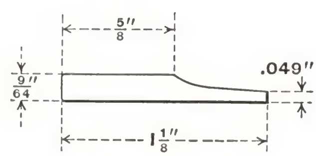
Size 3/8" to 1 1/2" inclusive, advancing by 64ths
Size 1 1/2" to 2 1/16" inclusive, advancing by 32nds

Decimal sizes can be rolled by special arrangement.
For Weights—See Table of Hexagon Bars, page 329

LAWN MOWER BLADE SECTIONS

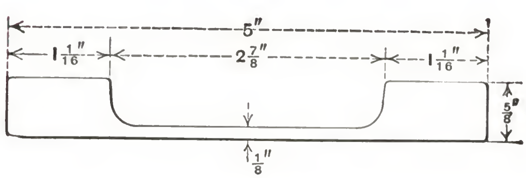


M 1096
0.92 Pounds per Foot



M 1497
0.42 Pounds per Foot

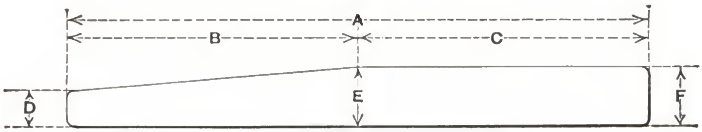
MANHOLE RING BAR SECTION



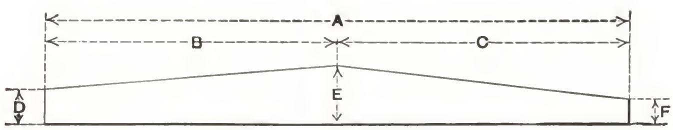
M 732
5.88 Pounds per Foot

Rolled for
The Davis Welding & Mfg. Co.

KNIFE BAR SECTIONS

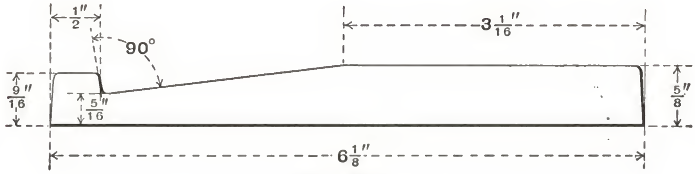


Section Number	DIMENSIONS IN INCHES						Pounds per Foot
	A	B	C	D	E	F	
M 924	5 9/16	2 1/16	3 1/2	.246	.500	.500	8.54
M 925	6 1/8	3 1/16	3 1/16	.370	.625	.625	11.68
M 1108	6 1/8	3 1/16	3 1/16	5/16	9/16	9/16	10.36
M 926	6 1/8	3 1/16	3 1/16	3/8	5/8	5/8	11.71

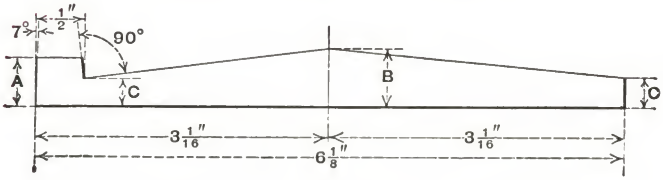


Section Number	DIMENSIONS IN INCHES						Pounds per Foot
	A	B	C	D	E	F	
M 927	5 5/8	3	2 5/8	3/8	5/8	1/4	9.00
M 929	5 5/8	3 1/16	2 9/16	.392	.637	.369	9.73
M 930	5 5/8	3 1/16	2 9/16	3/8	5/8	3/8	9.56
M 931	6 1/8	3 1/16	3 1/16	.370	.625	.3065	10.02
M 932	6 1/8	3 1/16	3 1/16	.3075	.5625	.244	8.72
M 933	6 1/8	3 1/16	3 1/16	3/8	5/8	5/16	10.08
M 934	6 1/8	3 1/16	3 1/16	3/8	5/8	1/4	9.76
M 936	6 1/8	3 1/16	3 1/16	3/8	5/8	3/8	10.41
M 938	6 1/8	3 1/16	3 1/16	3/8	5/8	3/16	9.44
M 939	6 1/8	3 1/16	3 1/16	5/16	9/16	3/8	9.43
M 940	6 1/8	3 1/16	3 1/16	1/4	1/2	5/16	8.13
M 941	6 1/8	3 1/16	3 1/16	3/8	9/16	1/2	10.41
M 942	6 5/8	3 9/16	3 1/16	3/8	5/8	3/8	11.26
M 1195	6 1/8	3 1/16	3 1/16	3/8	5/8	1/2	11.06

KNIFE BAR SECTIONS

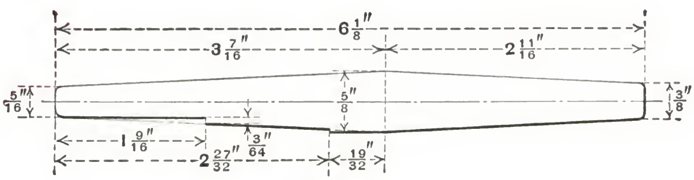


M 1461
11.67 Pounds per Foot
Rolled for Dilts Machine Works, Inc.

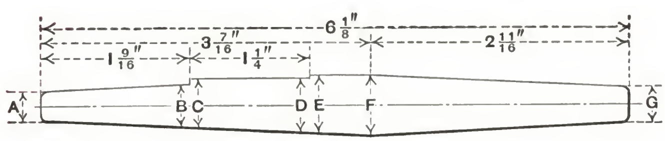


Section Number	DIMENSIONS IN INCHES			Pounds per Foot
	A	B	C	
M 964	½	⅝	5/16	9.75
M 964	9/16	11/16	⅜	11.05

Rolled for Dilts Machine Works, Inc.

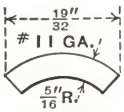


M 923
9.69 Pounds per Foot

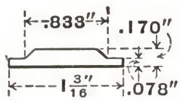


Section Number	DIMENSIONS IN INCHES							Pounds per Foot
	A	B	C	D	E	F	G	
M 921	.3075	.4518	.5095	.5673	.5961	.625	.375	10.16

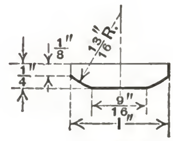
MISCELLANEOUS SECTIONS



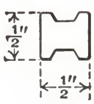
M 1502
0.24 Pounds per Foot



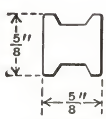
M 1694
0.56 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.



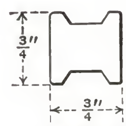
M 212
0.76 Pounds per Foot
Rolled for
Foster Bros. Mfg. Co., Inc.



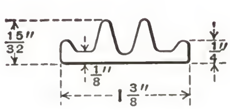
M 1169
0.69 Pounds per Foot
Rolled for
Anchor Post Fence Co.



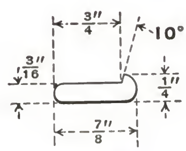
M 1170
1.07 Pounds per Foot
Rolled for
Anchor Post Fence Co.



M 1171
1.54 Pounds per Foot
Rolled for
Anchor Post Fence Co.

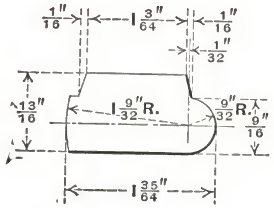


M 1353
1.10 Pounds per Foot
Rolled for
Standard Pressed Steel Co.

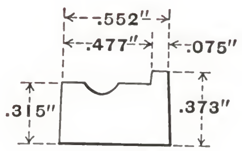


M 1268
0.55 Pounds per Foot
Rolled for
Troy Sunshade Co.

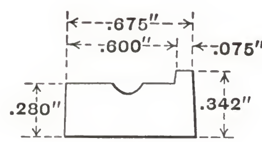
MISCELLANEOUS SECTIONS



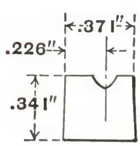
M 1118
3.87 Pounds per Foot



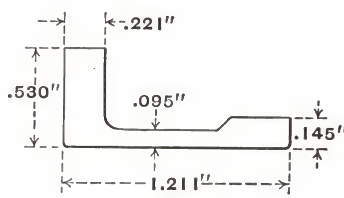
M 1599
0.60 Pounds per Foot



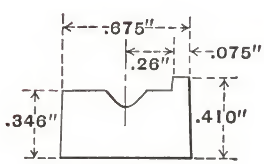
M 1600
0.65 Pounds per Foot



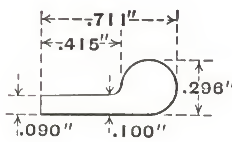
M 1625
0.43 Pounds per Foot



M 1626
0.78 Pounds per Foot



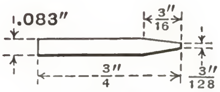
M 1633
0.79 Pounds per Foot



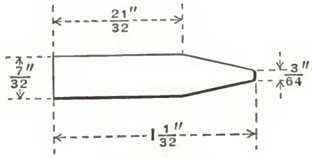
M 1638
0.39 Pounds per Foot

All Rolled for Moltrup Steel Products Co.

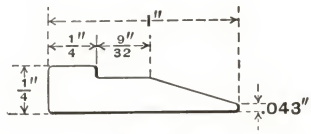
MISCELLANEOUS SECTIONS



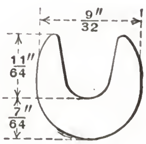
M 1476
0.19 Pounds per Foot



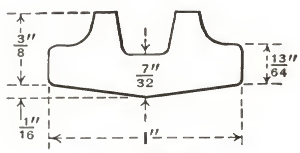
M 1226
0.66 Pounds per Foot



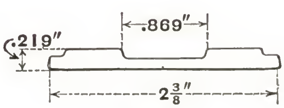
M 1710
0.56 Pounds per Foot
Rolled for
Bingham Stamping & Tool Co.



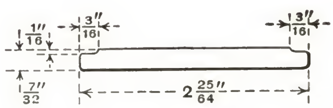
M 1689
0.19 Pounds per Foot



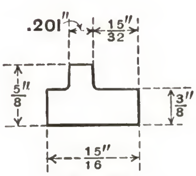
M 1632
0.96 Pounds per Foot
Rolled for
Sinclair Refining Co.



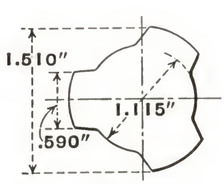
M 1773
1.40 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.



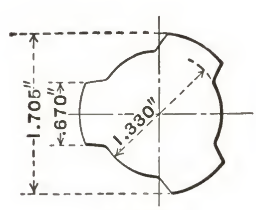
M 1645
1.70 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.



M 1031
1.38 Pounds per Foot
Rolled for
Moltrup Steel Products Co.

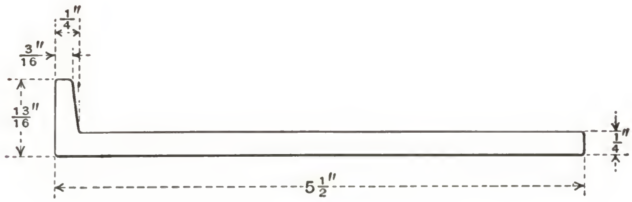


M 1693
4.68 Pounds per Foot
Rolled for
Moltrup Steel Products Co.

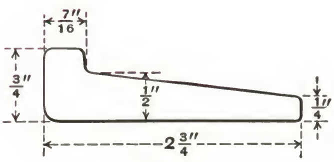


M 1715
6.06 Pounds per Foot
Rolled for
Moltrup Steel Products Co.

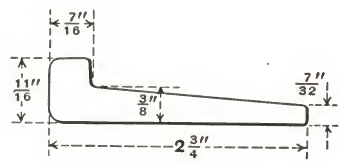
MISCELLANEOUS SECTIONS



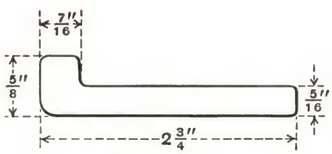
M 1066
5.10 Pounds per Foot
Rolled for
Lock Joint Pipe Co.



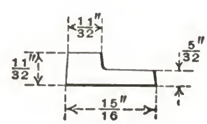
M 1180
4.05 Pounds per Foot



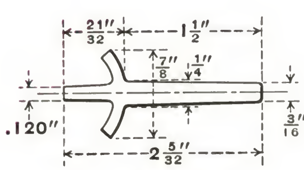
M 1181
3.34 Pounds per Foot



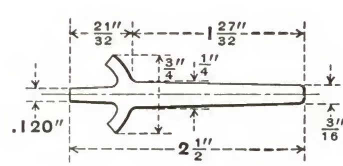
M 1182
3.37 Pounds per Foot



M 1032
0.72 Pounds per Foot
Rolled for
Moltrup Steel Products Co.

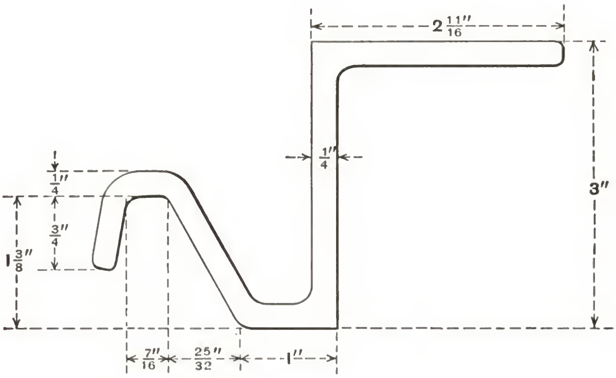


M 1359
1.77 Pounds per Foot
Rolled for
American Barlock Co., Inc.

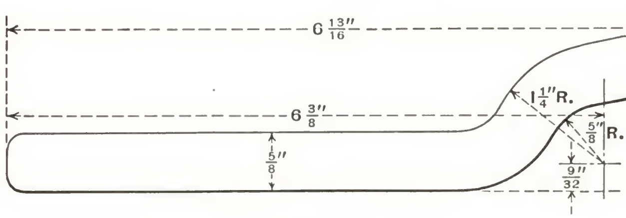


M 1360
1.94 Pounds per Foot
Rolled for
American Barlock Co., Inc.

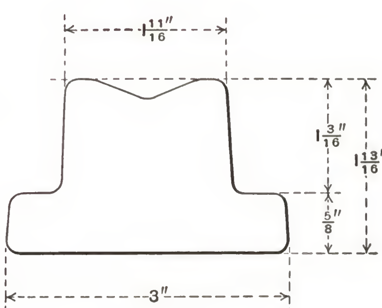
MISCELLANEOUS SECTIONS



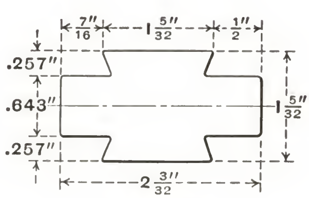
M 1252
7.89 Pounds per Foot
Rolled for
The Pennsylvania Railroad



M 1654
15.04 Pounds per Foot
Rolled for
American Foundry Equipment Co.

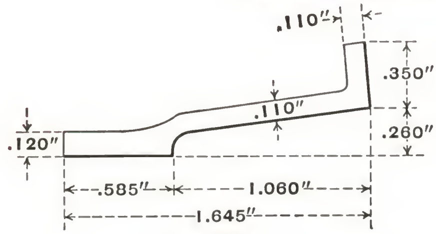


M 1755
13.00 Pounds per Foot

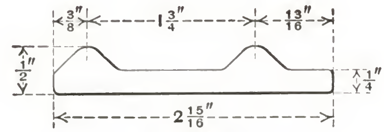


M 1671
6.44 Pounds per Foot
Rolled for
Wyckoff Drawn Steel Co.

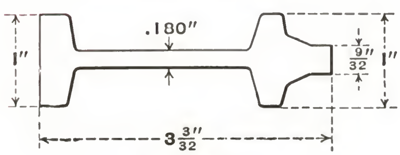
MISCELLANEOUS SECTIONS



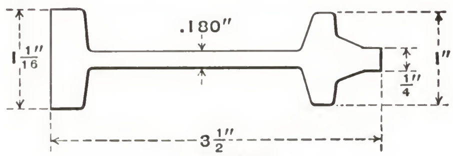
M 1674
0.78 Pounds per Foot
Rolled for
Moltrup Steel Products Co.



M 366
3.18 Pounds per Foot
Rolled for
Peerless Wire Fence Co.

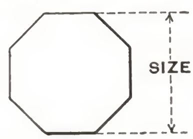


M 1680
4.05 Pounds per Foot
Rolled for
Reliance Steel Products Co.



M 1679
4.40 Pounds per Foot
Rolled for
Reliance Steel Products Co.

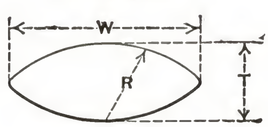
OCTAGONS



Size 1/4" to 3/4", inclusive, advancing by 32nds
Size 3/4" to 1 1/2", inclusive, advancing by 16ths
Size 1 1/2" to 2", inclusive, advancing by 8ths
Size 2" to 2 1/2", inclusive, advancing by 4ths

For weights, see table of Octagon Bars, page 330

OVALS

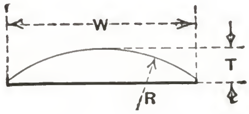


*Blunt

Section Number	DIMENSIONS IN INCHES			Pounds per Foot	Section Number	DIMENSIONS IN INCHES			Pounds per Foot
	W	T	R			W	T	R	
M 614	5/8	5/16	27/64	.48	*M 1508	7/8	7/16	13/16	1.05
M 619	3/4	3/8	17/32	.69	*M 627	1	1/2	11/16	1.19
M 623	7/8	3/8	21/32	.80	M 1772	1 1/2	3/8	1 31/32	1.40
M 624	7/8	7/16	19/32	.93					

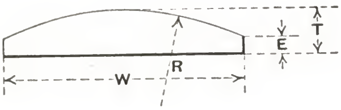
HALF OVALS

SHARP



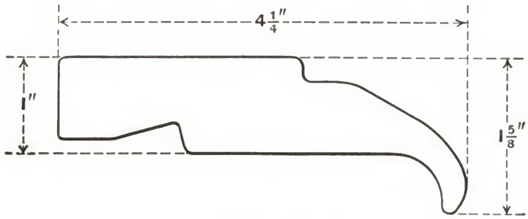
Section Number	DIMENSIONS IN INCHES			Pounds per Foot	Section Number	DIMENSIONS IN INCHES			Pounds per Foot
	W	T	R			W	T	R	
M 1525	1/2	No. 13 .095	33/64	0.13	M 654	1 1/8	9/32	25/32	0.79
M 117	1/2	No. 12 .109	17/32	0.15	M 655	1 1/4	1/4	1	0.77
M 632	1/2	1/8	3/8	0.16	M 656	1 1/4	5/16	27/32	0.97
M 634	1/2	3/16	9/32	0.24	M 658	1 1/4	3/8	25/32	1.19
M 637	5/8	5/32	7/16	0.25	M 1656	1 1/2	3/16	1 31/32	0.70
M 638	5/8	3/16	25/64	0.30	M 660	1 1/2	5/16	1 1/8	1.13
M 641	3/4	3/16	17/32	0.36	M 661	1 1/2	3/8	1	1.38
M 643	3/4	1/4	7/16	0.48	M 1683	1 1/2	7/16	59/64	1.64
M 645	7/8	3/16	11/16	0.41	M 1777	1 3/4	5/16	1 9/16	1.39
M 646	7/8	7/32	41/64	0.49	M 665	1 3/4	3/8	1 5/16	1.61
M 647	7/8	1/4	35/64	0.55	M 666	1 3/4	7/16	1 5/32	1.87
M 649	15/16	1/4	5/8	0.59	M 670	2	1/2	1 3/8	2.51
M 650	1	3/16	15/16	0.48	M 675	2 1/2	5/8	1 3/4	3.91
M 651	1	1/4	3/4	0.65	M 1256	2 3/4	3/4	1 13/16	5.19
M 727	1	3/8	35/64	0.95	M 678	3	3/4	2 1/8	5.71

BLUNT

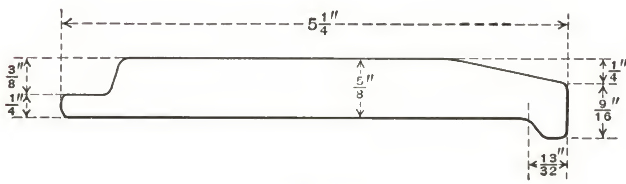


Section Number	DIMENSIONS IN INCHES				Pounds per Foot
	W	T	R	E	
M 132	2	3/8	2 1/8	1/8	2.00
M 470	2 1/2	1/2	2 21/32	3/16	3.39
M 472	3	1/2	4	3/16	4.13
M 473	3	5/8	3 1/16	3/16	5.09
M 478	3 1/2	3/4	3 3/16	3/16	6.94
M 479	4	1/2	5 13/16	1/8	5.21
M 480	4	3/4	4	3/16	7.85

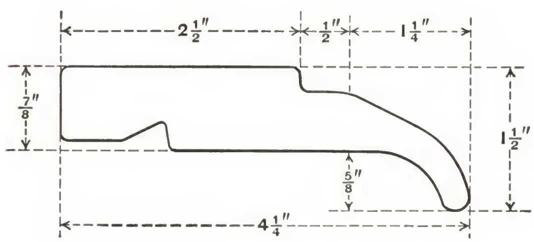
PIPE COUPLING SECTIONS



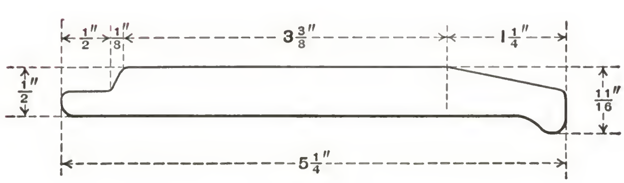
M 1102
11.30 Pounds per Foot



M 1103
10.09 Pounds per Foot



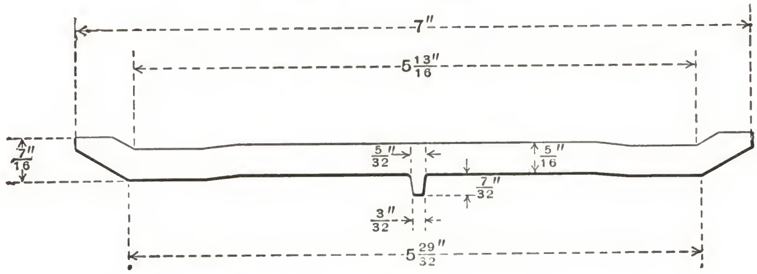
M 1140
9.85 Pounds per Foot



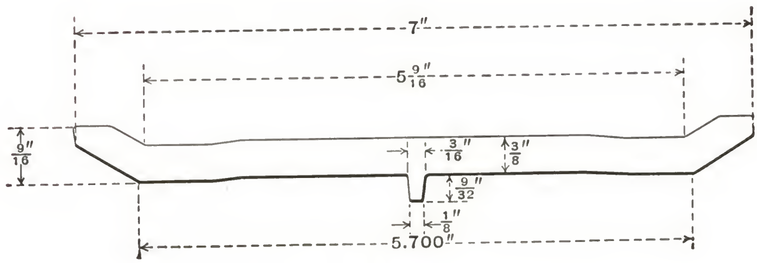
M 1141
8.28 Pounds per Foot

All rolled for Lock Joint Pipe Co.

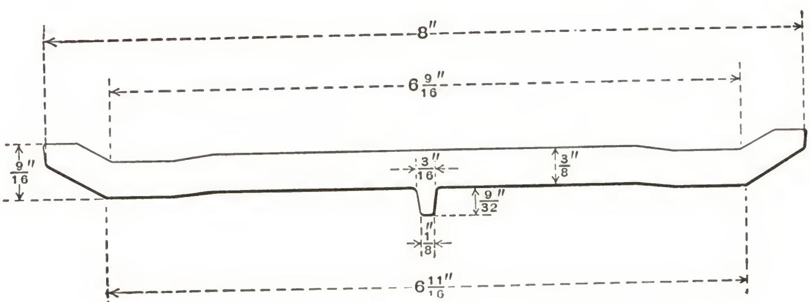
PIPE COUPLING SECTIONS



M 1331
7.48 Pounds per Foot

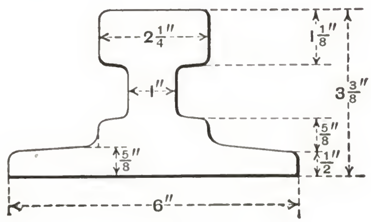


M 1330
8.97 Pounds per Foot



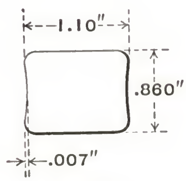
M 1332
10.25 Pounds per Foot
All rolled for S. R. Dresser Mfg. Co.

RACK RAIL SECTION

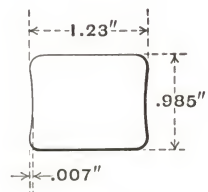


M 1101
28.6 Pounds per Foot
Rolled for
Duff-Norton Mfg. Co.

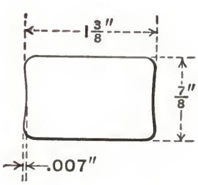
RAIL ANCHOR BARS



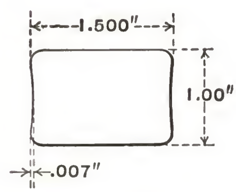
M 1292
3.14 Pounds per Foot



M 1376
4.20 Pounds per Foot

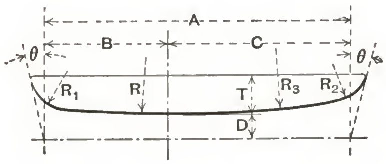


M 1364
4.04 Pounds per Foot



M 1477
5.20 Pounds per Foot

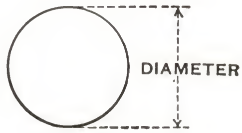
RAIL REINFORCING SECTIONS



Section Number	Type of Rail	DIMENSIONS IN INCHES									θ Degrees	Pounds per Foot
		A	B	C	D	T	R	R_1	R_2	R_3		
M 143	80 A.S.	2 5/8	1 5/16	1 5/16	35/128	3/8	12	1/4	1/4	.....	13	3.33
M 137	85 A.S.	2 3/4	1 3/8	1 3/8	9/32	3/8	12	1/4	1/4	.....	13	3.45
M 138	90 A.S.	2 55/64	1 27/64	1 7/16	9/32	3/8	12	1/4	1/4	.....	13	3.57
M 138	90 A.S.	2 55/64	1 27/64	1 7/16	9/32	1/2	12	1/4	1/4	.....	13	4.92
M 139	90 R.A.	3 5/32	1 1/4	1 29/32	9/32	3/8	14	3/8	3/8	.....	14	3.81
M 140	100 R.E.	3 9/32	1 3/8	1 29/32	9/32	3/8	14	3/8	5/8	.....	14	3.88
M 142	100 A.R.A.	3 3/8	1 1/2	1 7/8	9/32	5/16	14	3/8	3/8	.....	14	3.32
M 142	100 R.A.	3 3/8	1 1/2	1 7/8	9/32	3/8	14	3/8	3/8	.....	14	4.16
M 1687	105 Dudley	3 13/32	1 1/4	2 5/32	5/16	3/8	14	1/2	3/4	.....	14	3.88
M 1571	112 R.E.	3 13/16	1 3/16	2 5/8	19/64	1/2	10	3/8	5/8	23	14	6.31
M 141	130 R.E.	3 11/16	1 17/32	2 5/32	21/64	3/8	14	1/2	3/4	.....	14	4.31
M 141	130 R.E.	3 11/16	1 17/32	2 5/32	21/64	1/2	14	1/2	3/4	.....	14	6.02
M 1020	130 P.S.	3 13/32	1 3/8	2 1/32	11/32	3/8	16	1/2	3/4	.....	14†	4.15
M 1572	131 R.E.	4 3/16	1 1/8	3 1/16	21/64	1/2	10	1/2	3/4	23	14	6.68
M 1593	136 L.V.	3 7/8	1 5/8	2 1/4	21/64	3/8	14	1/2	3/4	.....	14	4.40

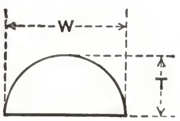
†Left angle adjoining R_1 is 18 degrees.

ROUNDS



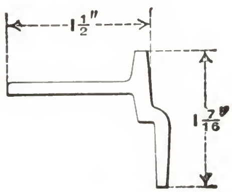
Diameters ¼″ to 8″ inclusive
Rounds can be rolled to decimal dimensions, by special arrangement.
Rounds 1⅜₂ inch and smaller can be furnished in coils.
For weights, see table on pages 300 to 302

HALF ROUNDS

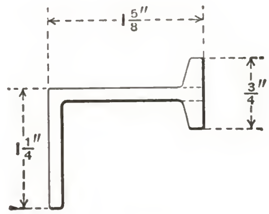


Section Number	W in.	T in.	Pounds per Foot
M 688	⅜	3/16	.19
M 690	½	¼	.33
M 693	⅝	5/16	.52
M 695	¾	⅜	.75
M 697	⅞	7/16	1.02
M 699	1	½	1.34
M 701	1½	¾	3.00
M 702	2	1	5.34
M 703	3	1½	12.02

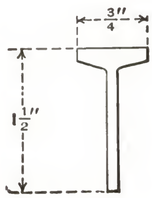
SASH AND CASEMENT SECTIONS



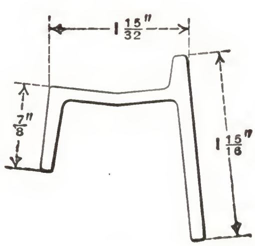
M 769
Customer's No. 35-G
1.31 Pounds per Foot



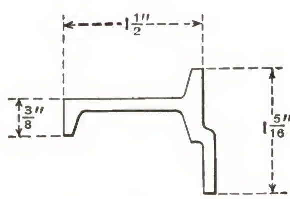
M 770
Customer's No. 36-E
1.53 Pounds per Foot



T 369
Customer's No. 30-B
1.00 Pound per Foot



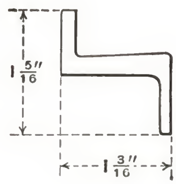
M 1049
Customer's No. 5-J
1.92 Pounds per Foot



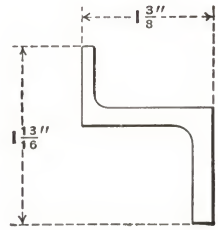
M 1480
Customer's No. S-45
1.41 Pounds per Foot

All rolled for William Bayley Co.

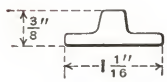
SASH AND CASEMENT SECTIONS



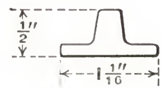
Z 11
Customer's No. 2
1.39 Pounds per Foot



Z-13
Customer's Zee Bar
1.81 Pounds per Foot

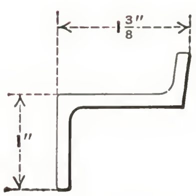


M 1289
Customer's No. 6
0.69 Pounds per Foot

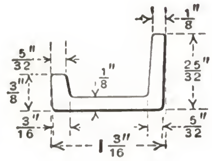


M 1290
Customer's No. 7
0.81 Pounds per Foot

All rolled for Richey, Browne & Donald, Inc.

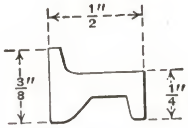


M 954
Customer's No. 107
1.12 Pounds per Foot
Rolled for
Bogert and Carlough Co.

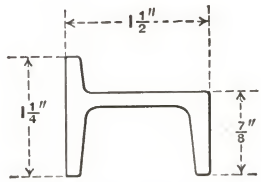


M 771
0.99 Pounds per Foot
Rolled for
Gabriel Steel Co.

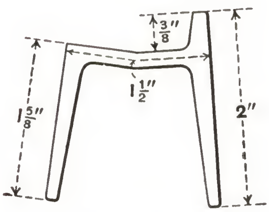
SASH AND CASEMENT SECTIONS



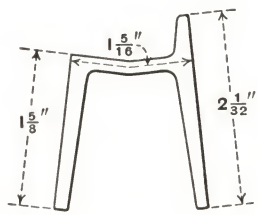
M 1446
Customer's No. 870 B
0.36 Pounds per Foot



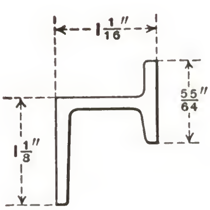
M 1459
Customer's No. 578
1.88 Pounds per Foot



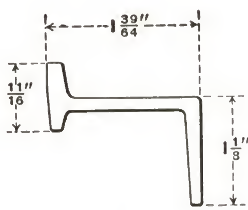
M 1365
Customer's No. 552
2.48 Pounds per Foot



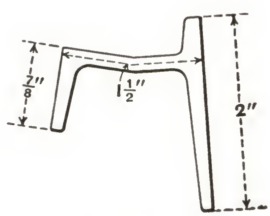
M 1444
Customer's No. 437-B
2.47 Pounds per Foot



M 1442
Customer's No. 567
1.17 Pounds per Foot



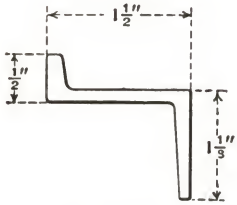
M 1478
Customer's No. 581
1.47 Pounds per Foot



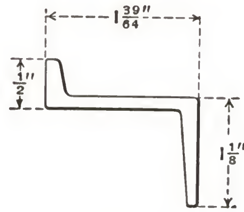
M 1372
Customer's No. 564
2.11 Pounds per Foot

All rolled for Campbell Metal Window Corporation

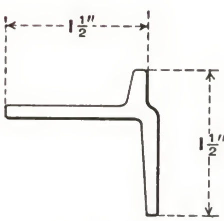
SASH AND CASEMENT SECTIONS



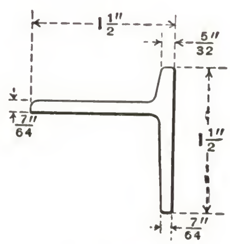
M 1367
Customer's No. 554
1.34 Pounds per Foot



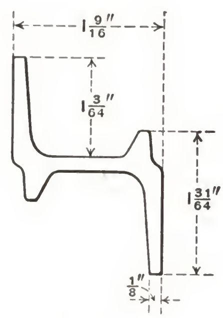
M 1370
Customer's No. 562
1.39 Pounds per Foot



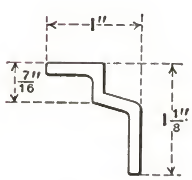
M 1371
Customer's No. 563
1.31 Pounds per Foot



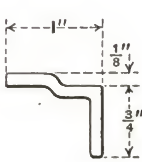
M 1366
Customer's No. 553
1.26 Pounds per Foot



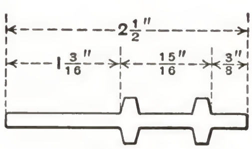
M 1449
Customer's No. 419-B
2.20 Pounds per Foot



M 1368
Customer's No. 557
0.83 Pounds per Foot



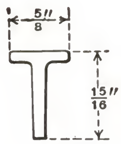
M 1369
Customer's No. 559
0.74 Pounds per Foot



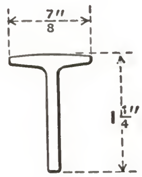
M 1445
Customer's No. 425-B
1.67 Pounds per Foot

All rolled for Campbell Metal Window Corporation

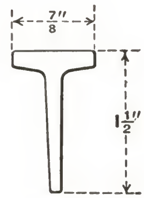
SASH AND CASEMENT SECTIONS



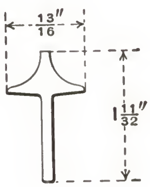
T 390
Customer's No. 568
0.62 Pounds per Foot



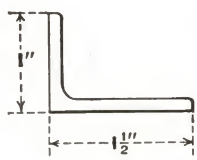
T 391
Customer's No. 722-H
0.89 Pounds per Foot



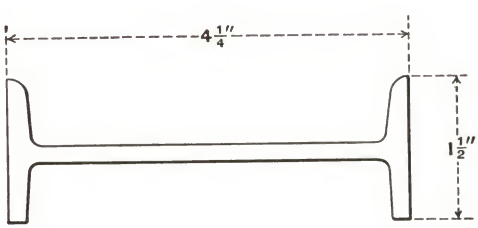
T 373
Customer's No. 555
1.16 Pounds per Foot



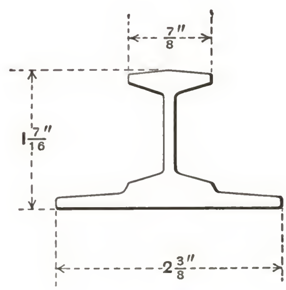
M 1553
Customer's No. 565
0.88 Pounds per Foot



A 19
Customer's No. 560
1.02 Pounds per Foot



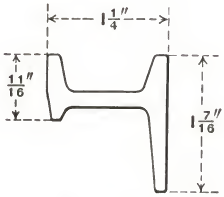
M 1457
Customer's No. 576
4.47 Pounds per Foot



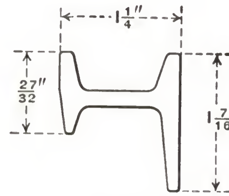
M 1451
Customer's No. 424-B
2.95 Pounds per Foot

All rolled for Campbell Metal Window Corporation

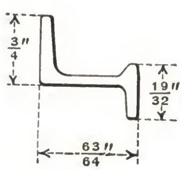
SASH AND CASEMENT SECTIONS



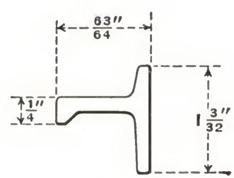
M 1249
Customer's No. 521



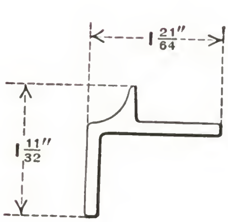
M 1277
Customer's No. S-531



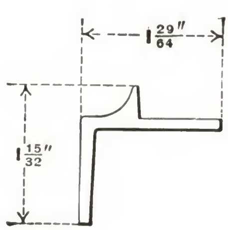
M 804
Customer's No. 148-R



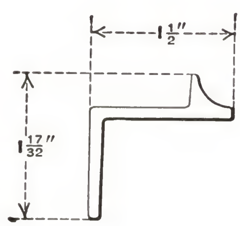
M 1340
Customer's No. 186



M 264
Customer's No. 94



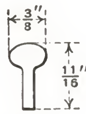
M 259
Customer's No. 70



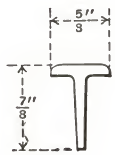
M 524
Customer's No. 71

All rolled for Detroit Steel Products Co.

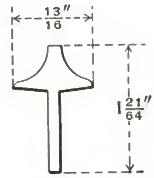
SASH AND CASEMENT SECTIONS



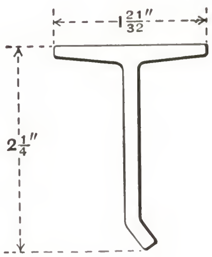
M 1149
Customer's No. 219



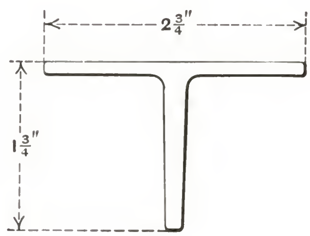
T 422
Customer's No. 155



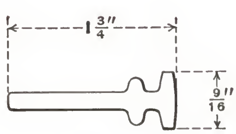
M 260
Customer's No. 90



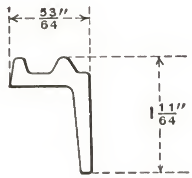
M 816
Customer's No. 151-R



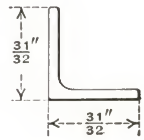
T 345
Customer's No. 209



M 1260
Customer's No. 523



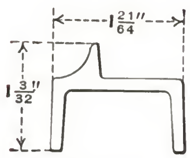
M 1338
Customer's No. 188



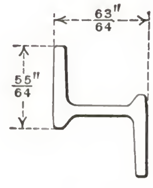
A 99
Customer's No. 85

All rolled for Detroit Steel Products Co.

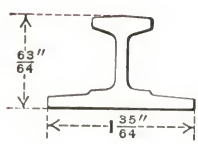
SASH AND CASEMENT SECTIONS



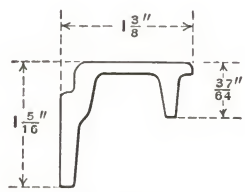
M 266
Customer's No. 192



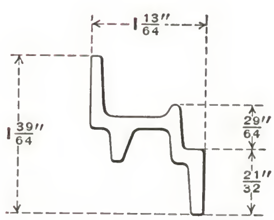
M 803
Customer's No. 149-R



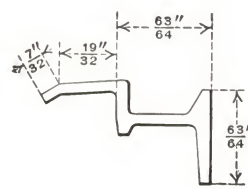
M 1036
Customer's No. 183-C



M 1165
Customer's No. 504-R



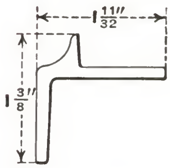
M 1339
Customer's No. 187



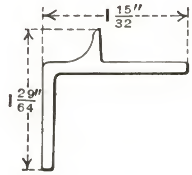
M 1041
Customer's No. 199-R

All rolled for Detroit Steel Products Co.

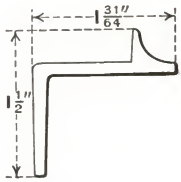
SASH AND CASEMENT SECTIONS



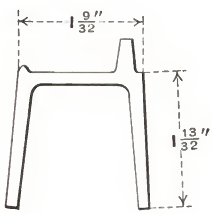
M 1144
Customer's No. 3
1.12 Pounds per Foot



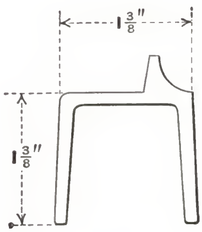
M 1147
Customer's No. 6
1.23 Pounds per Foot



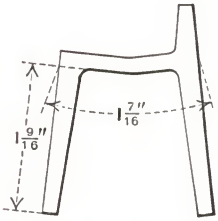
M 1146
Customer's No. 5
1.28 Pounds per Foot



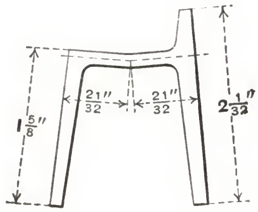
M 1137
Customer's No. 504
2.04 Pounds per Foot



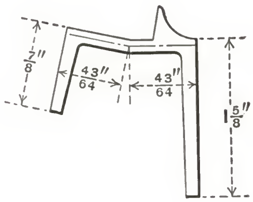
M 580
Customer's No. 4
2.07 Pounds per Foot



M 786
Customer's No. 104
2.60 Pounds per Foot



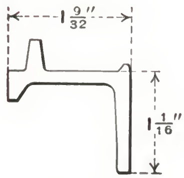
M 1136
Customer's No. 404
2.42 Pounds per Foot



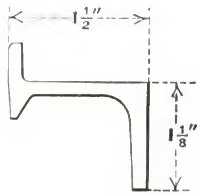
M 1160
Customer's No. 11
1.82 Pounds per Foot

All rolled for J. S. Thorn Co.

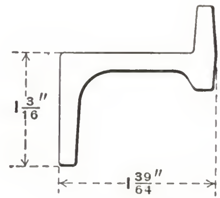
SASH AND CASEMENT SECTIONS



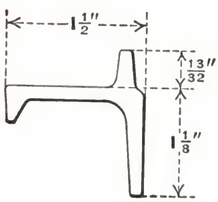
M 1130
Customer's No. 501
1.37 Pounds per Foot



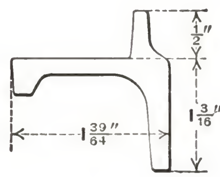
M 1061
Customer's No. 401
1.74 Pounds per Foot



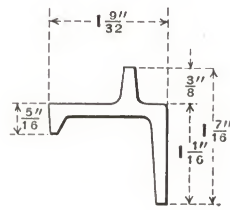
M 784
Customer's No. 101
2.33 Pounds per Foot



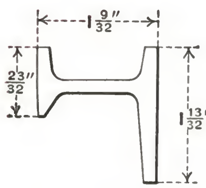
M 1060
Customer's No. 400
1.77 Pounds per Foot



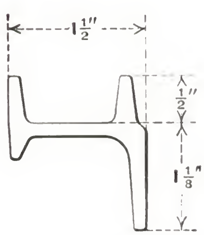
M 783
Customer's No. 100
2.30 Pounds per Foot



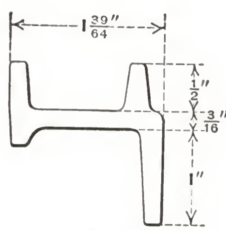
M 1189
Customer's No. 500
1.35 Pounds per Foot



M 1131
Customer's No. 502
1.53 Pounds per Foot



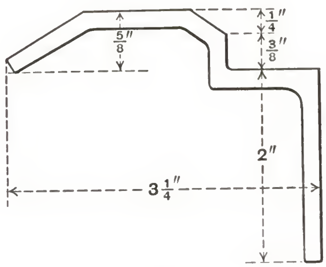
M 1100
Customer's No. 402
2.11 Pounds per Foot



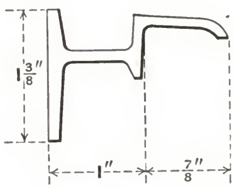
M 790
Customer's No. 102
2.55 Pounds per Foot

All rolled for J. S. Thorn Co.

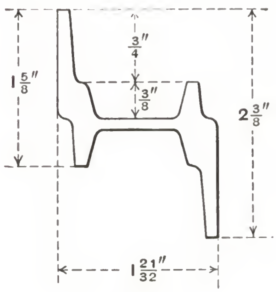
SASH AND CASEMENT SECTIONS



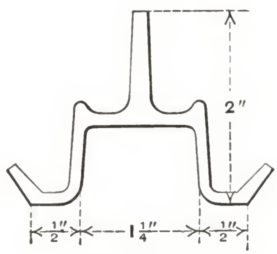
M 1306
Customer's No. 70
3.60 Pounds per Foot



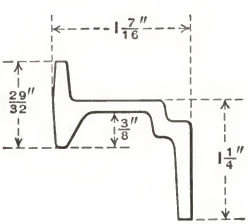
M 1067
Customer's No. 202
1.57 Pounds per Foot



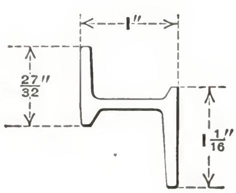
M 1246
Customer's No. 405
3.02 Pounds per Foot



M 577
Customer's No. 30
2.81 Pounds per Foot



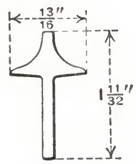
M 1291
Customer's No. 306
1.78 Pounds per Foot



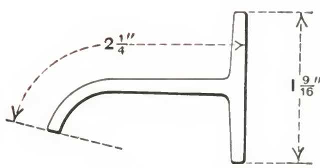
M 815
Customer's No. 204
1.16 Pounds per Foot

All rolled for J. S. Thorn Co.

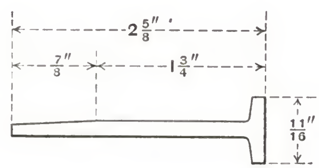
SASH AND CASEMENT SECTIONS



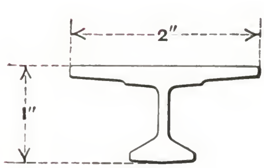
M 1145
Customer's No. 1
0.88 Pounds per Foot



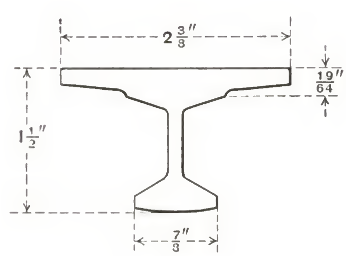
M 1094
Customer's No. 206
1.79 Pounds per Foot



M 1598
Customer's No. 309
1.66 Pounds per Foot



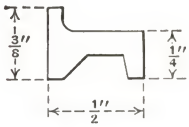
M 1068
Customer's No. 203
1.70 Pounds per Foot



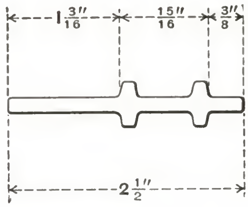
M 1245
Customer's No. 403
3.18 Pounds per Foot

All rolled for J. S. Thorn Co.

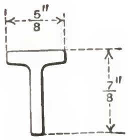
SASH AND CASEMENT SECTIONS



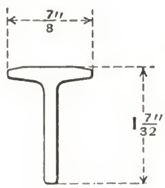
M 1300
Customer's No. 393
0.36 Pounds per Foot



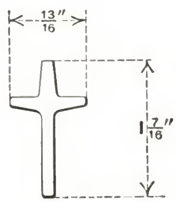
M 1299
Customer's No. 391
1.67 Pounds per Foot



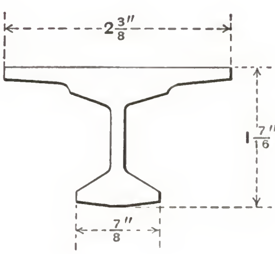
T 347
Customer's No. 249
0.61 Pounds per Foot



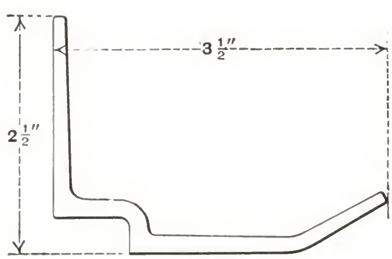
T 365
Customer's No. 390
0.88 Pounds per Foot



M 1064
Customer's No. 201
0.97 Pounds per Foot



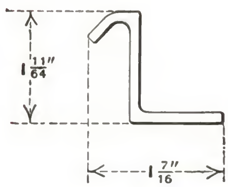
M 1730
Customer's No. 392
2.95 Pounds per Foot



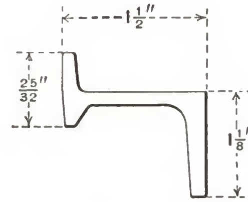
M 1078
Customer's No. 39
3.28 Pounds per Foot

All rolled for Truscon Steel Co.

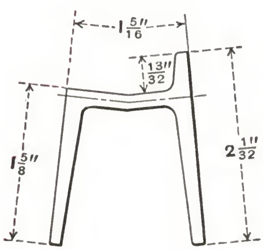
SASH AND CASEMENT SECTIONS



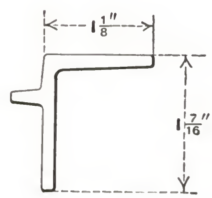
M 1046
Customer's No. 247
0.96 Pounds per Foot



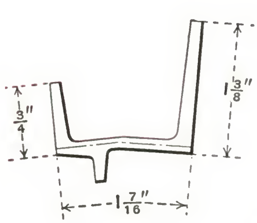
M 1320
Customer's No. 388
1.74 Pounds per Foot



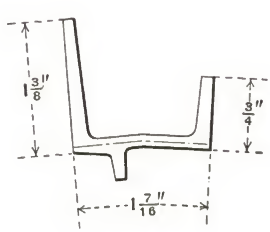
M 1321
Customer's No. 386
2.47 Pounds per Foot



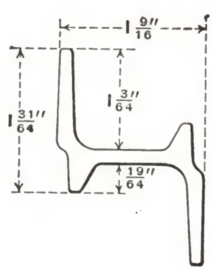
M 1065
Customer's No. 204
1.27 Pounds per Foot



M 1157
Customer's No. 210-A
1.69 Pounds per Foot



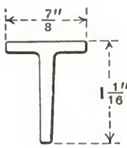
M 1158
Customer's No. 210-B
1.69 Pounds per Foot



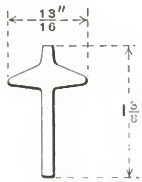
M 1322
Customer's No. 440
2.20 Pounds per Foot

All rolled for Truscon Steel Co.

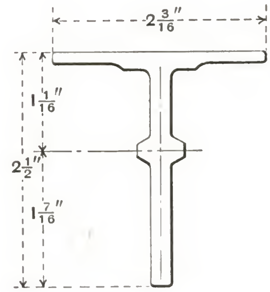
SASH AND CASEMENT SECTIONS



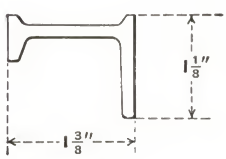
T 364
0.75 Pounds per Foot



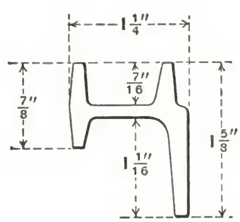
M 593
0.95 Pounds per Foot



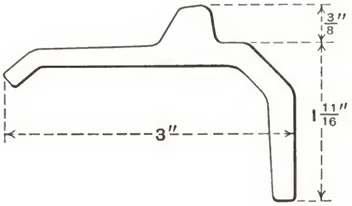
M 1329
2.74 Pounds per Foot



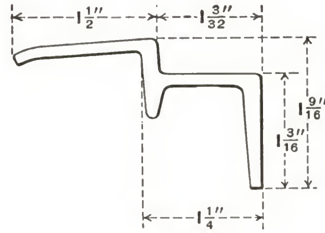
M 1324
1.30 Pounds per Foot



M 1361
1.82 Pounds per Foot

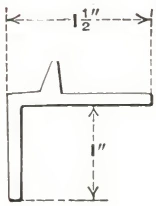


M 776
3.48 Pounds per Foot

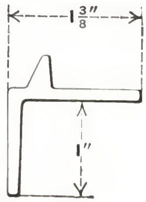


M 1328
2.14 Pounds per Foot

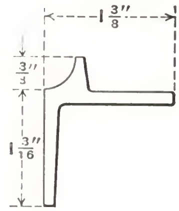
SASH AND CASEMENT SECTIONS



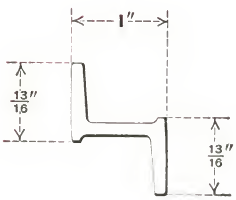
M 774
1.27 Pounds per Foot



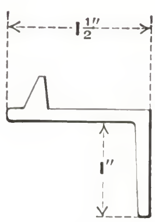
M 594
1.22 Pounds per Foot



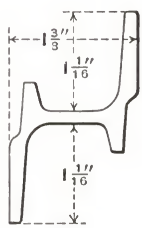
M 1114
1.25 Pounds per Foot



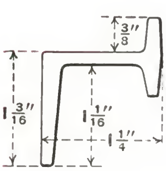
M 1042
1.09 Pounds per Foot



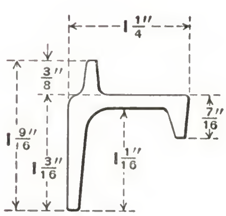
M 773
1.27 Pounds per Foot



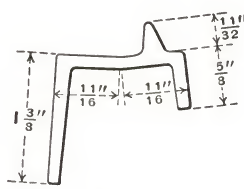
M 1325
2.05 Pounds per Foot



M 1327
1.48 Pounds per Foot

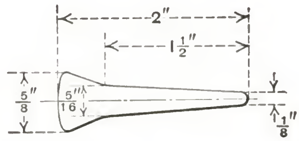


M 1326
1.54 Pounds per Foot



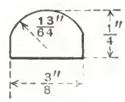
M 1312
1.61 Pounds per Foot

SCREEN SECTION



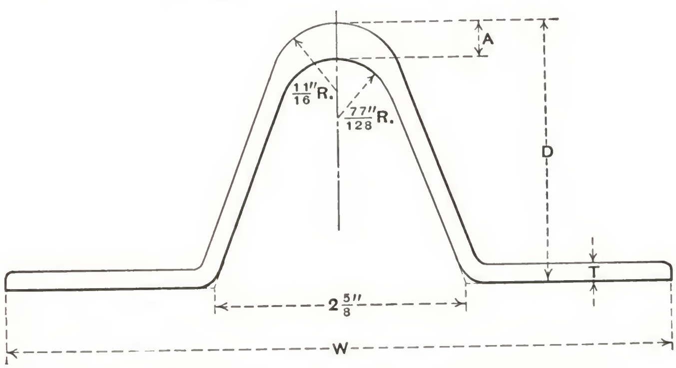
M 962
1.88 Pounds per Foot

SHIM SECTION



M 17
0.27 Pounds per Foot

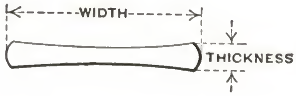
SIDE STAKE SECTION



Section Number	DIMENSIONS IN INCHES				Pounds per Foot
	W	D	T	A	
L 2	7	$2\frac{3}{4}$	$\frac{3}{16}$	$\frac{3}{8}$	7.2
L 2	7	$2\frac{13}{16}$	$\frac{1}{4}$	$\frac{7}{16}$	8.7
L 2	7	$2\frac{15}{16}$	$\frac{3}{8}$	$\frac{9}{16}$	11.7

SPRING STEEL

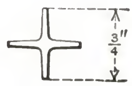
ROUND EDGE CONCAVE OR VEHICLE



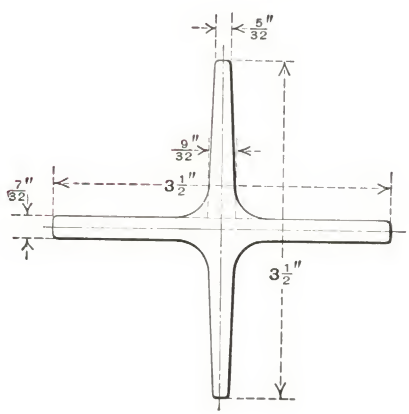
$1\frac{1}{4}''$	to $2\frac{1}{2}''$	wide x No. 11 B.W.G.	to $\frac{1}{2}''$
over $2\frac{1}{2}''$	to $4''$	wide x No. 7 B.W.G.	to $\frac{1}{2}''$
over $4''$	to $5''$	wide x No. 2 B.W.G.	to $\frac{9}{16}''$
over $5''$	to $6''$	wide x $\frac{5}{16}''$	to $\frac{1}{2}''$

Flat Spring Steel can be furnished within the range of Round Edge Flats

STAR SECTIONS



M 386
0.32 Pounds per Foot



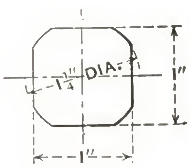
M 1043
5.33 Pounds per Foot
Rolled for
Art Metal Construction Co.

SQUARES

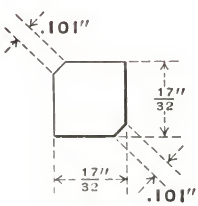
Size ¼″ to 3″ inclusive.
Squares can be rolled to decimal dimensions, by special arrangement.
Squares 1⁵⁄₁₆ inch and smaller can be furnished in coils.
For weights, see tables on pages 300–301

SQUARES

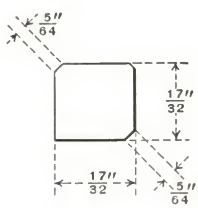
SPECIAL



M 1557
3.30 Pounds per Foot

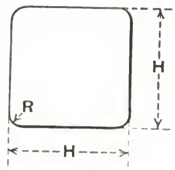


M 1510
0.94 Pounds per Foot



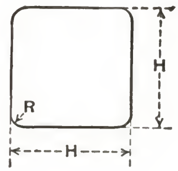
M 1495
0.94 Pounds per Foot

SQUARES—ROUND CORNERED



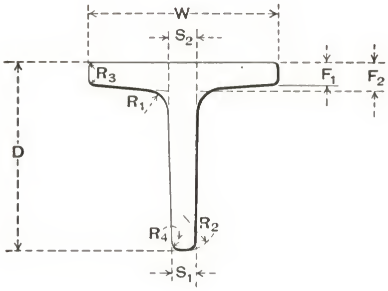
Section Number	DIMENSIONS IN INCHES			Pounds per Foot to the nearest hundredth	Equivalent Standard Size, Inches
	Nominal Size H	Actual Size H	R		
M 761	3/8	0.375	3/64	0.47	....
M 1310	7/16	0.43	1/16	0.62	....
M 1302	31/64	0.49	1/16	0.81	....
M 762	1/2	0.50	1/16	0.84	....
M 1642	9/16	0.5625	1/32	1.07	....
M 1604	7/8	0.8826	1/8	2.60	7/8 Square
M 1640	1	1.0066	1/8	3.40	1 Square
M 1555	1 1/16	1.069	1/8	3.84	1 1/16 Square
M 1505	1 3/32	1.094	1/16	4.06	....
M 1536	1 1/8	1.125	1/8	4.26	....
M 1117	1 1/4	1.25	3/16	5.21	....
M 1537	1 1/4	1.25	1/8	5.27	....
M 1263	1 5/16	1.3175	1/8	5.86	1 5/16 Square
M 1456	1 3/8	1.379	1/8	6.43	1 3/8 Square
M 1050	1 7/16	1.4375	1/8	6.98	....
M 1104	1 7/16	1.4422	1/8	7.03	1 7/16 Square
M 1045	1 1/2	1.5	5/16	7.36	....
M 1051	1 1/2	1.5044	1/8	7.65	1 1/2 Square
M 1120	1 17/32	1.5357	1/8	7.97	1 17/32 Square
M 1163	1 9/16	1.5625	13/64	8.18	1 3/4 Round
M 1248	1 9/16	1.5625	5/16	8.02	....
M 877	1 9/16	1.567	1/8	8.30	1 9/16 Square
M 1383	1 19/32	1.59375	5/16	8.35	....
M 1053	1 5/8	1.625	5/16	8.69	....
M 807	1 5/8	1.629	1/8	8.98	1 5/8 Square
M 1218	1 21/32	1.66	1/8	9.32	1 21/32 Square
M 1109	1 11/16	1.6867	5/16	9.39	1 7/8 Round
M 1132	1 11/16	1.6915	1/8	9.68	1 11/16 Square
M 1155	1 3/4	1.75	5/16	10.13	....
M 1062	1 3/4	1.754	1/8	10.41	1 3/4 Square
M 878	1 3/4	1.776	1/8	10.68	2 Round
M 1127	1 25/32	1.785	1/8	10.79	1 25/32 Square
M 1121	1 25/32	1.7959	5/16	10.68	2 Round
M 1323	1 13/16	1.8134	5/16	10.90	....
M 1728	1 13/16	1.817	1/8	11.17	1 13/16 Square
M 1152	1 7/8	1.875	5/16	11.67	....
M 1056	1 7/8	1.87	1/8	11.95	1 7/8 Square

SQUARES—ROUND CORNERED



Section Number	DIMENSIONS IN INCHES Nominal Size H	Actual Size H	R	Pounds per Foot to the nearest hundredth	Equivalent Standard Size, Inches
M 1073	1 29/32	1.9054	5/16	12.06	2 1/8 Round
M 1513	1 59/64	1.928	5/16	12.35	1 29/32 Square
M 1352	1 15/16	1.9375	5/16	12.48	....
M 1191	1 15/16	1.9409	1/8	12.76	1 15/16 Square
M 1063	2	2.007	3/16	13.60	2 Square
M 1474	2 1/16	2.0625	5/16	14.18	....
M 1119	2 1/16	2.0625	0.569	13.52	2 1/4 Round
M 1527	2 5/64	2.0657	1/8	14.46	2 1/16 Square
M 1258	2 1/8	2.125	5/16	15.06	2 3/8 Round
M 1057	2 1/8	2.132	3/16	15.35	2 1/8 Square
M 879	2 3/16	2.1905	1/8	16.27	2 3/16 Square
M 1148	2 1/4	2.2568	3/16	17.21	2 1/4 Square
M 1058	2 5/16	2.319	3/16	18.18	2 5/16 Square
M 1113	2 3/8	2.378	1/8	19.18	2 3/8 Square
M 1219	2 3/8	2.381	3/16	19.18	2 3/8 Square
M 1059	2 1/2	2.506	3/16	21.25	2 1/2 Square
M 1196	2 11/16	2.6975	1/4	24.56	2 11/16 Square
M 1242	2 23/32	2.71875	5/16	24.85	....
M 1129	2 49/64	2.765	5/16	25.71	2 3/4 Square
M 1123	2 13/16	2.8125	5/16	26.62	....
M 1133	2 7/8	2.8844	1/4	28.10	2 7/8 Square
M 1482	2 15/16	2.9466	1/4	29.34	2 15/16 Square
M 880	3	3.014	5/16	30.60	3 Square
M 1386	3 1/16	3.0625	5/16	31.60	....
M 1500	3 1/8	3.125	5/16	32.92	....
M 1168	3 1/8	3.138	5/16	33.20	3 1/8 Square
M 1488	3 3/16	3.1875	5/16	34.26	....
M 881	3 1/4	3.2633	5/16	35.92	3 1/4 Square
M 1489	3 3/8	3.375	1/2	38.00	....
M 1356	3 3/8	3.3873	5/16	38.73	3 3/8 Square
M 1125	3 1/2	3.512	5/16	41.65	3 1/2 Square
M 1257	3 5/8	3.637	5/16	44.68	3 5/8 Square
M 1203	3 3/4	3.7618	5/16	47.82	3 3/4 Square
M 1176	4	4.015	5/16	54.40	4 Square

TEES



EQUAL TEES

Section Number	DIMENSIONS IN INCHES										Pounds per Foot
	W	D	S_1	S_2	F_1	F_2	R_1	R_2	R_3	R_4	
T 5	1	1	1/8	5/32	1/8	5/32	1/8	.....	.....	.....	0.91
T 188	1 1/4	1 1/4	3/16	9/32	3/16	7/32	5/32	3/16	.....	.....	1.72
T 191	1 1/2	1 1/2	3/16	7/32	3/16	7/32	3/16	.....	.....	.....	1.98
T 363	1 1/2	1 1/2	3/16	7/32	3/16	7/32	3/16	.....	1/16	.....	1.97
T 193	1 1/2	1 1/2	1/4	9/32	1/4	9/32	3/16	.....	.....	.....	2.51
T 194	1 3/4	1 3/4	1/4	5/16	1/4	5/16	3/16	.....	.....	.....	3.12
* T 405	2	2	3/16	15/64	3/16	.200	1/4	.....	.....	.....	2.70
T 353	2	2	1/4	5/16	1/4	5/16	1/4	.....	1/32	3/32	3.62
T 37	2	2	1/4	5/16	5/16	3/8	1/4	.....	.....	.....	3.63
T 39	2	2	5/16	3/8	3/16	.200	1/4	.....	.....	.....	4.35
T 41	2 1/4	2 1/4	1/4	5/16	1/4	5/16	1/4	.....	.....	.....	4.12
* T 361	2 1/4	2 1/4	5/16	3/4° to Side	13/64	1/4	1/4	.....	1/16	5/64	4.13
T 42	2 1/4	2 1/4	5/16	3/8	5/16	3/8	1/4	.....	.....	.....	4.94
T 47	2 1/2	2 1/2	1/4	5/16	1/4	5/16	1/4	.....	.....	.....	4.60
T 354	2 1/2	2 1/2	5/16	3/8	5/16	3/8	1/4	.....	1/32	3/32	5.51
T 49	2 1/2	2 1/2	5/16	3/8	5/16	3/8	1/4	.....	.....	.....	5.53
* T 351	3	3	1/2	9/16	3/4	13/16	3/8	.....	.....	.....	12.16

UNEQUAL TEES

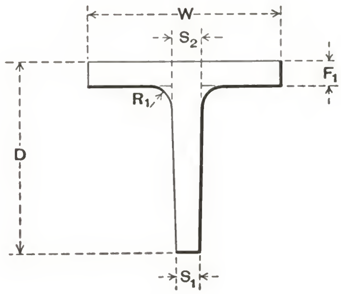
Section Number	DIMENSIONS IN INCHES										Pounds per Foot
	W	D	S_1	S_2	F_1	F_2	R_1	R_2	R_3	R_4	
* T 373	7/8	1 1/2	7/64	5/32	5/32	7/32	3/32	.....	.....	.....	1.16
T 20	1 1/2	1 1/4	1/8	5/32	1/8	5/32	1/8	.....	.....	.....	1.27
* T 359	2 1/2	2 3/8	3/8	3/4° to Side	15/64	9/32	5/16	.....	1/16	5/64	5.20
* T 360	3	2 3/8	3/8	3/4° to Side	15/64	9/32	5/16	.....	1/16	5/64	5.64
T 394	3	2 1/2	5/16	3/8	5/16	3/8	5/16	.....	1/32	3/32	6.14
* T 346	3 1/2	2 1/2	9/32	11/32	3/16	1/4	1/4	.....	.....	.....	5.12
* T 362	3 1/2	3	3/8	3/4° to Side	17/64	5/16	3/8	.....	1/16	5/64	7.39

Other sizes of tees may be furnished by special arrangement.

*Rolled only by special arrangement.

Weights of above Tee sections include fillets and roundings.

TEES



EQUAL TEES

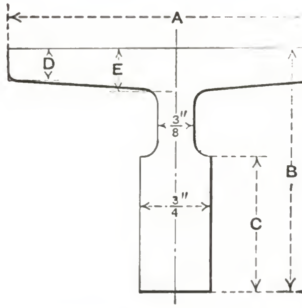
Section Number	DIMENSIONS IN INCHES						Pounds per Foot
	W	D	S_1	S_2	F_1	R_1	
T 349	3/4	3/4	1/8	1° to Side	1/8	1/16	0.62
T 352	7/8	7/8	1/8	1° to Side	1/8	1/16	0.73
T 350	1	1	1/8	1° to Side	1/8	1/16	0.85
T 396	1 1/4	1 1/4	7/64	1/2° to Side	1/8	1/16	1.00
T 358	1 1/4	1 1/4	1/8	1° to Side	1/8	1/16	1.09

UNEQUAL TEES

Section Number	DIMENSIONS IN INCHES						Pounds per Foot
	W	D	S_1	S_2	F_1	R_1	
* T 342	3/8	19/64	1/16	3/32	.064	....	0.15
* T 340	13/32	5/16	7/64	9/64	1/16	....	0.20
* T 390	5/8	15/16	7/64	9/64	1/8	1/16	0.62
T 364	7/8	1 1/16	7/64	1° to Side	7/64	1/16	0.74
T 341	1 1/2	1 1/16	3/16	0° to 1/2°	3/16	1/8	1.55
T 372	1 1/2	1 1/4	3/32	1/8	7/64	5/64	1.00
T 419	1 1/2	1 1/4	.100	.132	.113	5/64	1.04
* T 420	1.74	1.37	.128	.158	.113	.075	1.29
* T 424	1.74	1.37	.138	.158	.113	.075	1.31
* T 423	1.74	1.375	.140	.158	.109	.075	1.30
* T 409	1 3/4	1.698	.174	.199	.128	5/64	1.77
* T 411	1 3/4	1.823	.182	.209	.128	5/64	1.90
* T 413	1 3/4	1.948	.182	.211	.128	5/64	1.99
* T 425	2	1.312	.154	3/16	.109	3/32	1.46
* T 408	2	1.635	.174	.199	.128	5/64	1.84
* T 426	2	1.698	.174	.199	.128	5/64	1.88
* T 414	2	1.948	.182	.211	.128	5/64	2.10
* T 417	2	2.104	.182	.213	.128	5/64	2.21
* T 402	2	2.462	3/16	7/32	.212	1/4	3.09
* T 410	2 1/4	1.698	.174	.199	.128	5/64	1.98
* T 418	2 1/4	2.104	.182	.213	.128	5/64	2.32
* T 403	3	2 7/16	7/32	1/4	3/16	1/4	3.80
* T 404	3	2.524	7/32	1/4	.274	1/4	4.68

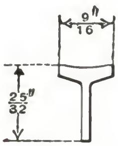
Other sizes of tees may be furnished by special arrangement.
*Rolled only by special arrangement.
Weights of above Tee sections include fillets and roundings.

TEES — ELEVATOR

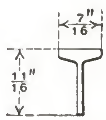


Section Number	DIMENSIONS IN INCHES					Pounds per Foot
	A	B	C	D	E	
T 231 T 232	3½ 5	2½ 3$\frac{9}{16}$	1$\frac{5}{16}$ 2$\frac{1}{32}$	$\frac{5}{16}$ ½	$\frac{7}{16}$ ⅝	8.9 16.1

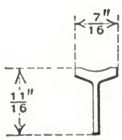
TEES — SLED RUNNER



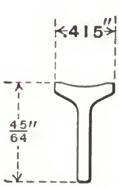
T 223
0.48 Pounds per Foot



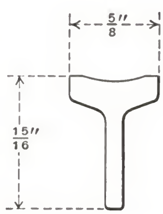
T 225
0.31 Pounds per Foot



T 330
0.27 Pounds per Foot

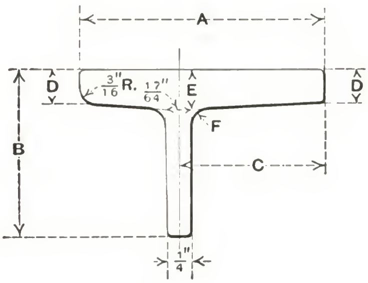


T 401
0.30 Pounds per Foot



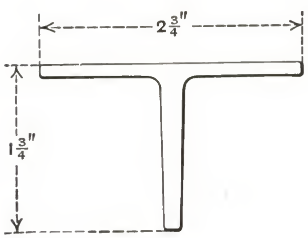
T 421
0.71 Pounds per Foot

TEES — SPECIAL

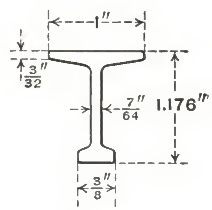


Section Number	Name	DIMENSIONS IN INCHES						Pounds per Foot
		A	B	C	D	E	F	
T 205	Binder	$2\frac{1}{2}$	$1\frac{23}{32}$	$1\frac{1}{2}$	$\frac{11}{32}$	$\frac{13}{32}$	$\frac{5}{32}$	4.35
T 205	Binder	$2\frac{1}{2}$	$1\frac{25}{32}$	$1\frac{1}{2}$	$\frac{13}{32}$	$\frac{15}{32}$	$\frac{5}{32}$	4.89

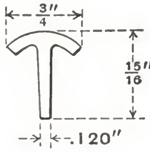
Rolled for Massey-Harris Co., Ltd.



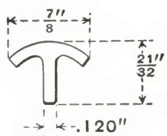
T 345
Rolled for
Detroit Steel Products Co.



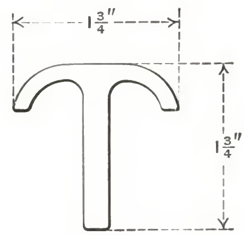
T 395
0.94 Pounds per Foot
Rolled for
The Irwin Seating Co.



T 371
0.71 Pounds per Foot
Rolled for
American Barlock Co., Inc.

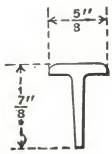


T 370
0.64 Pounds per Foot
Rolled for
American Barlock Co., Inc.

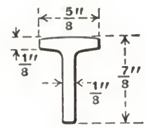


T 328
2.72 Pounds per Foot

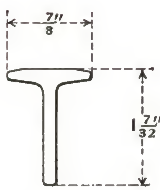
TEES — SPECIAL



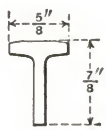
T 422
Rolled for
Detroit Steel Products Co.



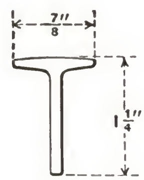
T 406
0.61 Pounds per Foot



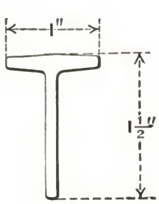
T 365
0.88 Pounds per Foot
Rolled for
Truscon Steel Co.



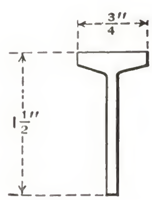
T 347
0.61 Pounds per Foot
Rolled for
Truscon Steel Co.



T 391
0.89 Pounds per Foot
Rolled for
Campbell Metal Window Corp.



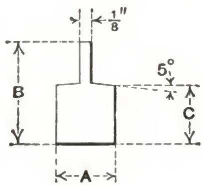
T 329
1.09 Pounds per Foot
Rolled for
Congdon and Carpenter Co.



T 369
1.00 Pound per Foot
Rolled for
William Bayley Co.

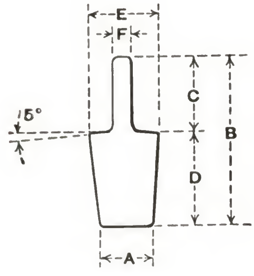
TOE CALK SECTIONS

SWEETS' BLUNT SPECIAL



Section Number	DIMENSIONS IN INCHES			Pounds per Foot
	A	B	C	
M 336	5/8	1 1/16	5/8	1.53
M 337	3/4	15/16	1/2	1.49

CITY PATTERN

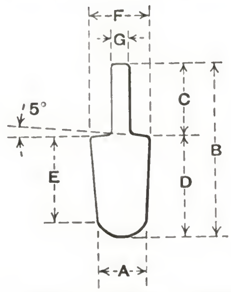


Section Number	DIMENSIONS IN INCHES						Pounds per Foot
	A	B	C	D	E	F	
M 353	9/32	7/8	3/8	1/2	3/8	3/32	0.68
M 354	11/32	15/16	3/8	9/16	7/16	1/8	0.91
M 355	13/32	1	3/8	5/8	1/2	1/8	1.13
M 356	13/32	1 3/16	7/16	3/4	1/2	1/8	1.35
M 357	1/2	1 1/4	7/16	13/16	9/16	1/8	1.66
M 358	17/32	1 5/16	7/16	7/8	9/16	5/32	1.87
M 359	17/32	1 3/8	7/16	15/16	19/32	5/32	2.04

All rolled for Phoenix Mfg. Co.

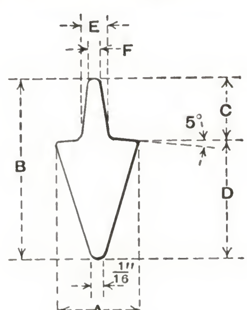
TOE CALK SECTIONS

COUNTRY PATTERN, CENTER NIB



Section Number	DIMENSIONS IN INCHES							Pounds per Foot
	A	B	C	D	E	F	G	
M 488	1/4	29/32	3/8	17/32	29/64	5/16	3/32	0.59
M 489	1/4	1 1/16	13/32	21/32	19/32	11/32	1/8	0.81
M 490	9/32	1 3/16	7/16	3/4	43/64	13/32	1/8	1.02
M 491	9/32	1 1/4	7/16	13/16	47/64	7/16	1/8	1.14
M 492	5/16	1 5/16	7/16	7/8	13/16	15/32	1/8	1.32
M 493	3/8	1 3/8	7/16	15/16	55/64	1/2	5/32	1.60

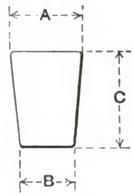
SHARP PATTERN



Section Number	DIMENSIONS IN INCHES						Pounds per Foot
	A	B	C	D	E	F	
M 339	7/16	15/16	5/16	5/8	1/8	1/16	0.64
M 340	1/2	1 1/8	3/8	3/4	1/8	3/32	0.87
M 341	9/16	1 1/4	3/8	7/8	9/64	3/32	1.09
M 342	9/16	1 3/8	7/16	15/16	9/64	3/32	1.19
M 343	5/8	1 7/16	7/16	1	5/32	3/32	1.37
M 344	5/8	1 1/2	7/16	1 1/16	5/32	3/32	1.44

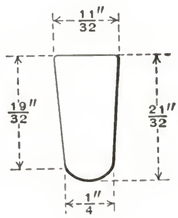
All rolled for Phoenix Mfg. Co.

TOE CALK SECTIONS



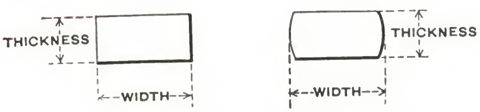
Section Number	DIMENSIONS IN INCHES			Pounds per Foot
	A	B	C	
M 1748	3/8	9/32	1/2	0.56
M 1749	7/16	11/32	9/16	0.75
M 1718	1/2	13/32	5/8	0.96
M 1751	1/2	13/32	3/4	1.16

Rolled for Phoenix Mfg. Co.



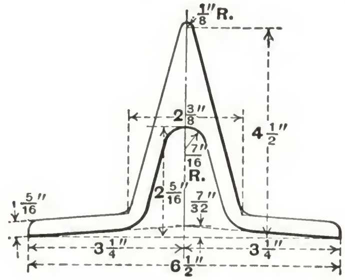
M 1750
0.64 Pounds per Foot
Rolled for Phoenix Mfg. Co.

TOE CALK STEEL



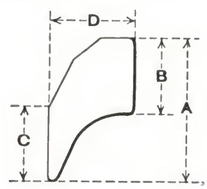
Width in.	THICKNESS	
	Square Edge in.	Round Edge in.
1/4 to 1	3/16 to 9/16	3/16 to 9/16
5/8 to 1 1/4	5/16 to 1	5/16 to 13/16

TRACTOR LUG SECTION



L 5
14.93 Pounds per Foot

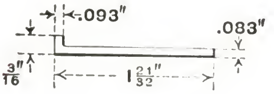
TURBINE BLADE SECTIONS



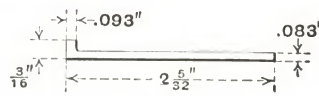
Section Number	DIMENSIONS IN INCHES				Customer's Number	Pounds per Foot
	A	B	C	D		
M 1758	1 57/64	15/16	15/16	1 3/16	5 F 541 B	4.06
M 1759	2 1/64	1 1/16	1 1/16	1 3/16	5 F 541 C	4.56
M 1760	2 9/64	1 3/16	1 3/16	1 3/16	5 F 541 D	5.07
M 1761	2 17/64	1 5/16	1 5/16	1 3/16	5 F 541 E	5.57
M 1762	2 19/32	1 7/16	1 13/32	1 7/16	5 F 641 D	7.44
M 1763	2 27/32	1 11/16	1 21/32	1 7/16	5 F 641 F	8.66
M 1764	3 5/32	1 3/4	1 3/4	1 11/16	5 F 741 E	10.58
M 1765	3 13/32	2	2	1 11/16	5 F 741 G	12.01

Rolled for Westinghouse Electric & Mfg. Co.

WEARING PLATE SECTIONS

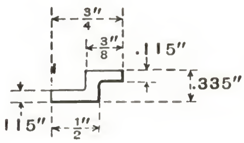


M 1038
0.50 Pounds per Foot
Rolled for
R. Herschel Mfg. Co.

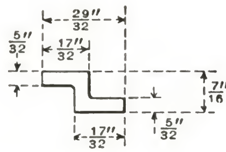


M 1039
0.64 Pounds per Foot
Rolled for
R. Herschel Mfg. Co.

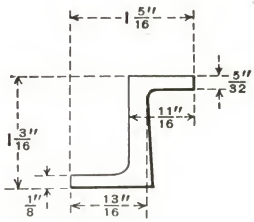
ZEES—SPECIAL



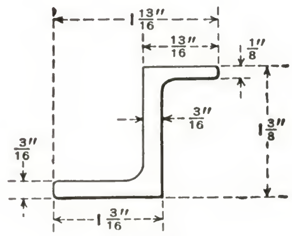
Z 03
0.39 Pounds per Foot
Rolled for
Moltrup Steel Products Co.



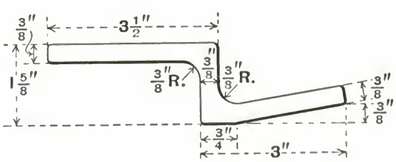
Z 04
0.63 Pounds per Foot
Rolled for
Moltrup Steel Products Co.



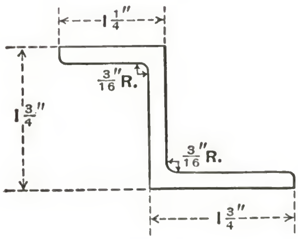
Z 11
1.39 Pounds per Foot
Rolled for
Richey, Browne & Donald, Inc.



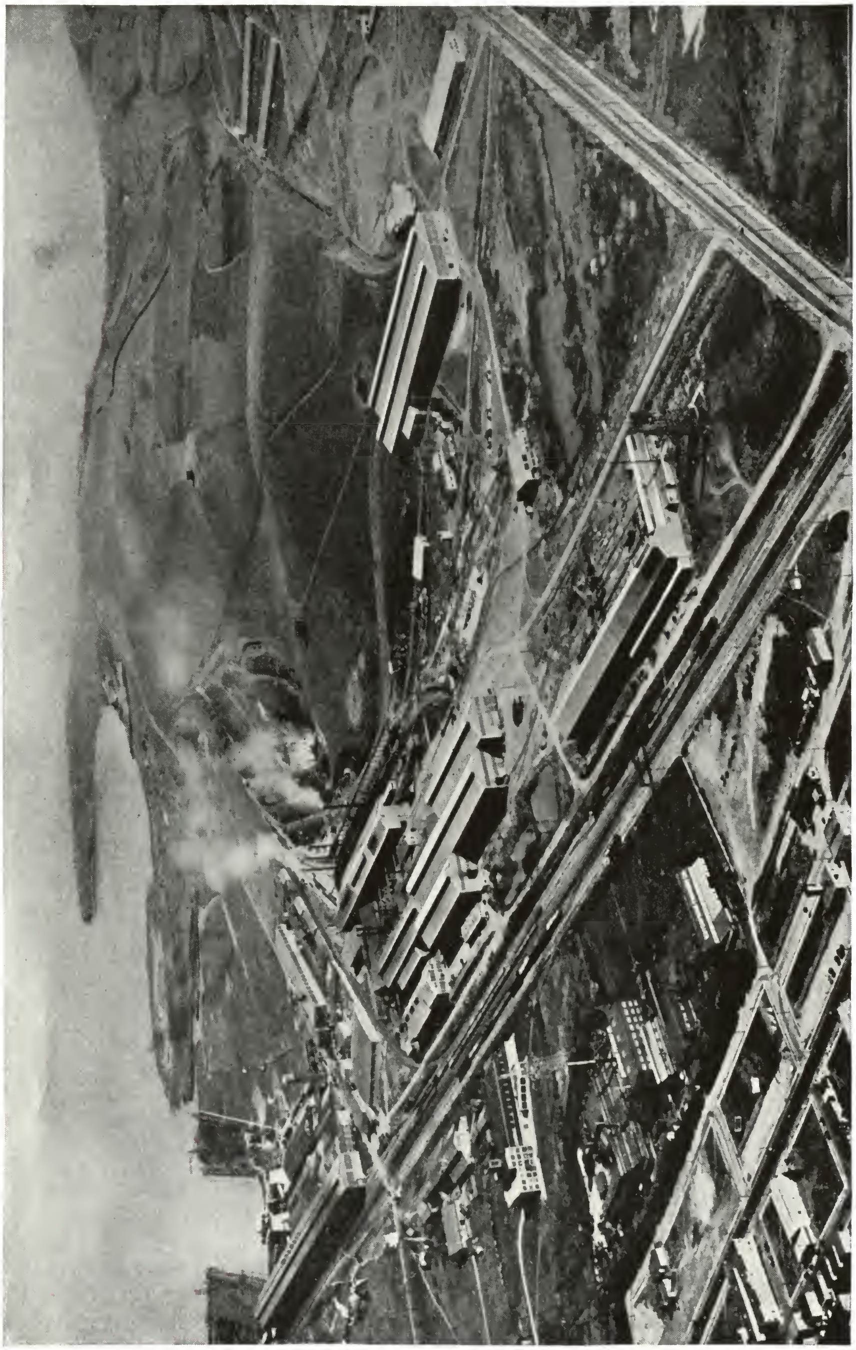
Z 13
1.81 Pounds per Foot
Rolled for
Richey, Browne & Donald, Inc.



Z 16
9.65 Pounds per Foot
Rolled for
The Pennsylvania Railroad



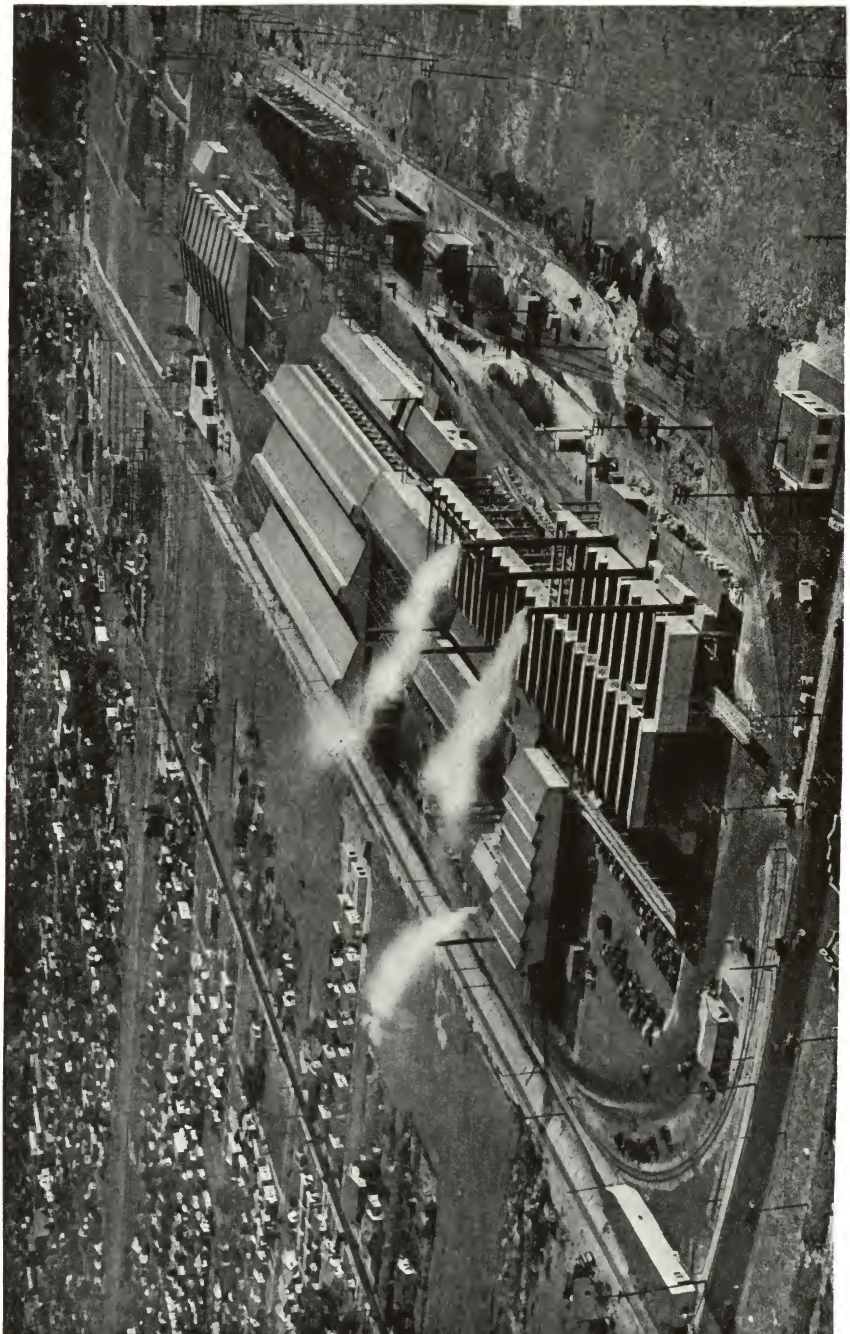
Z17a—3/16" Thickness, 2.84 Pounds per Foot
Z17a—1/4" Thickness, 3.66 Pounds per Foot
Rolled for
The Pennsylvania Railroad



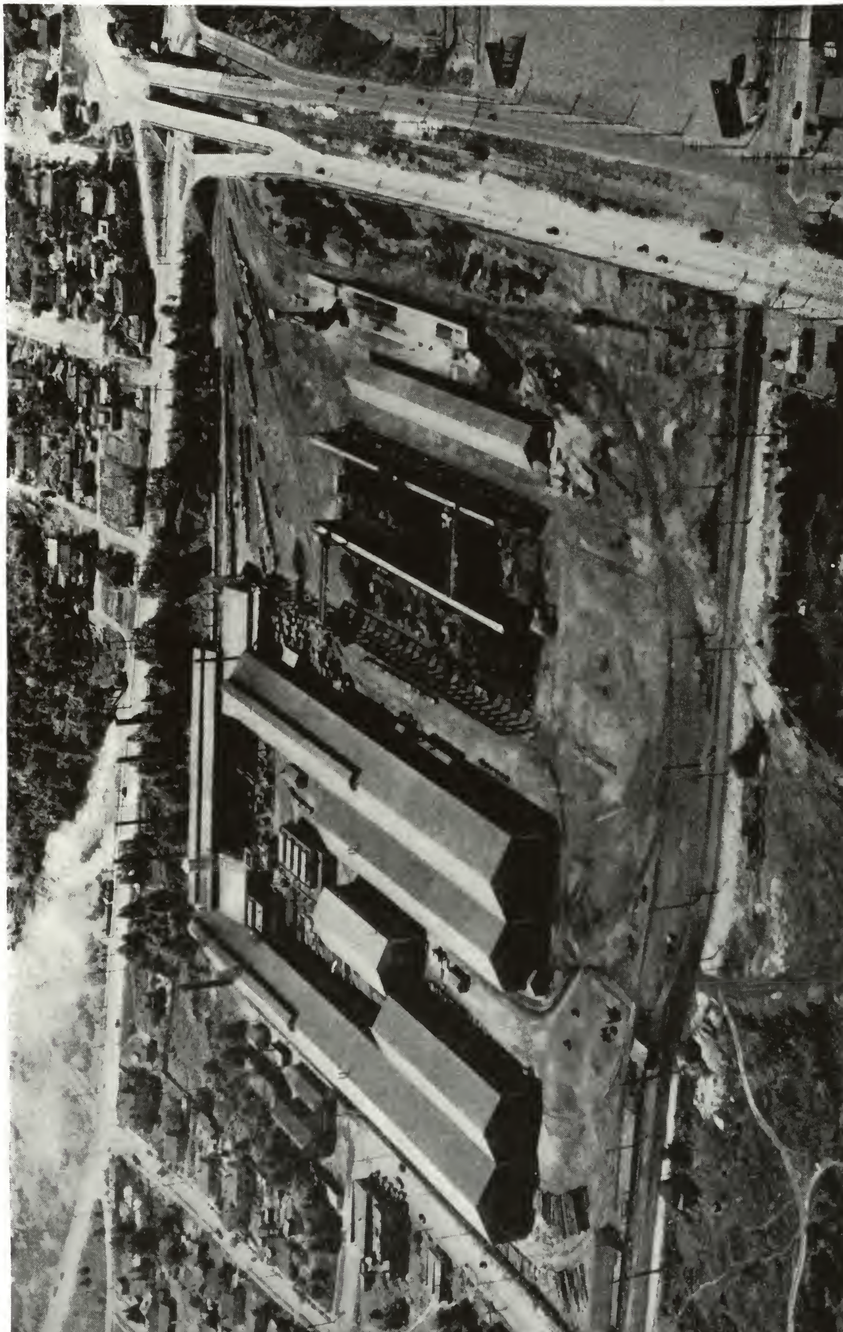
South San Francisco plant

PACIFIC COAST SECTIONS

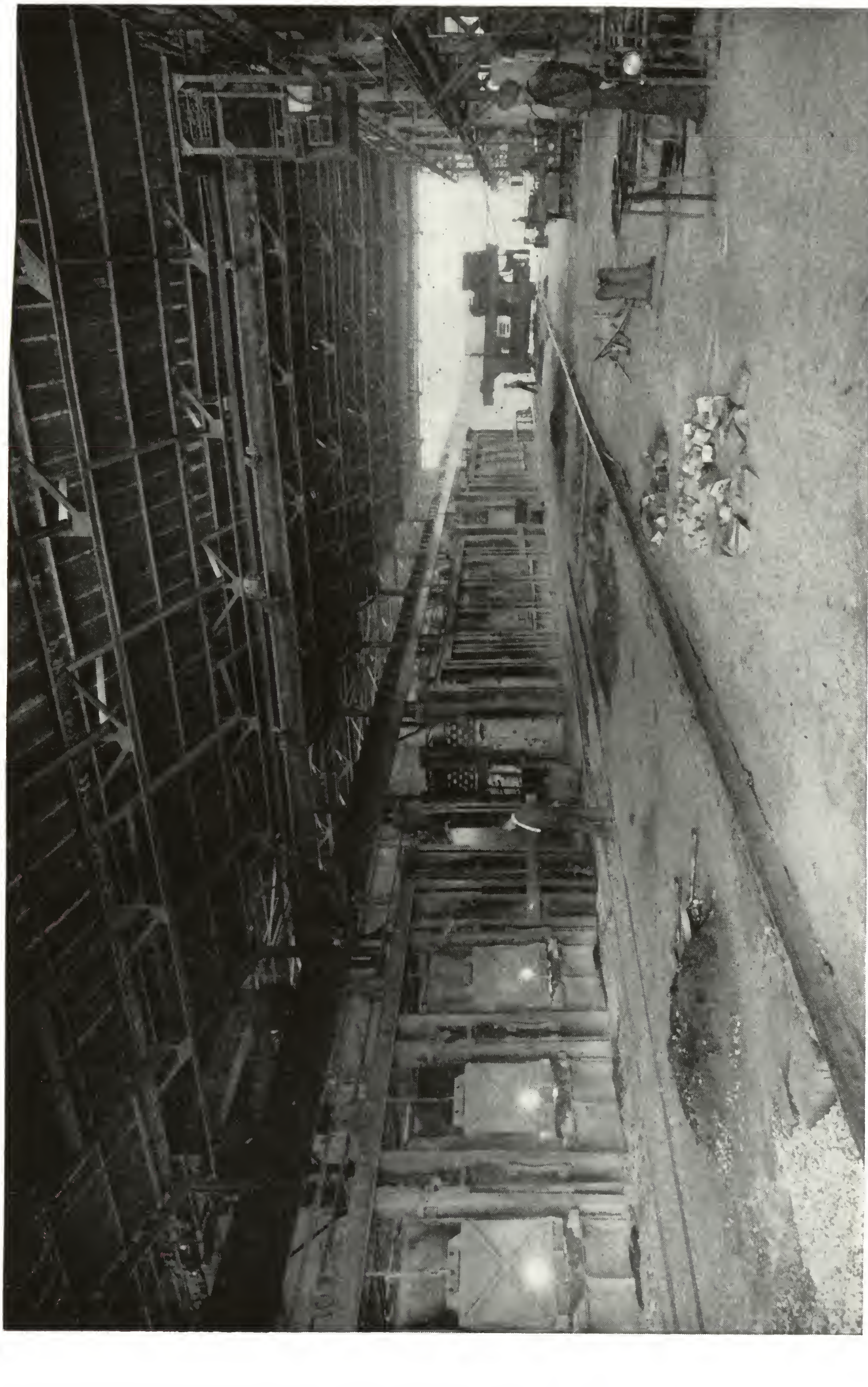
THE Sections shown on pages 134 to 148 are those which can be rolled at our South San Francisco, Los Angeles and Seattle plants.



Los Angeles plant

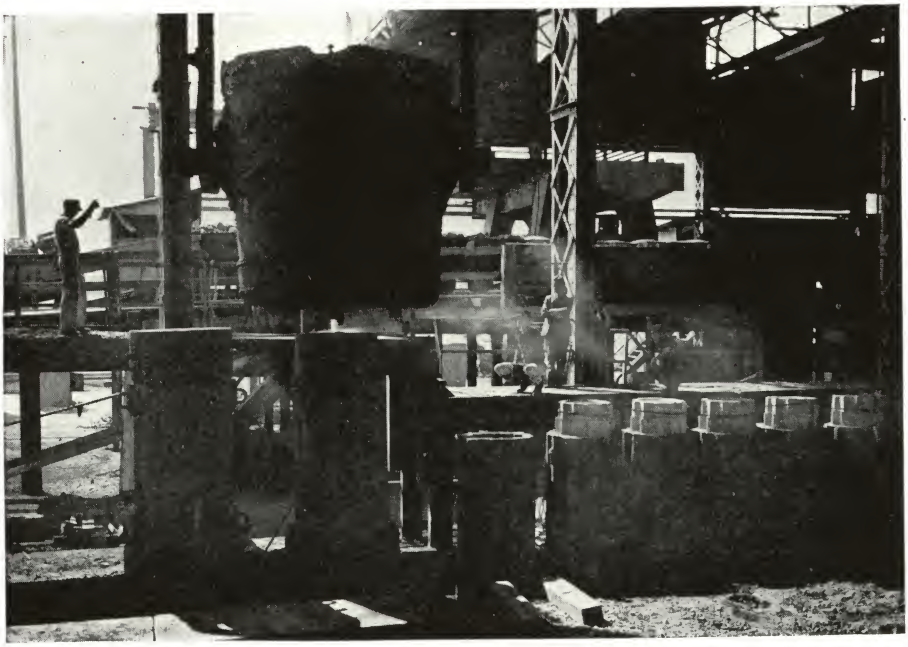


Seattle plant



Open hearth charging floor at the Los Angeles plant

Tapping open hearth furnace at the South San Francisco plant



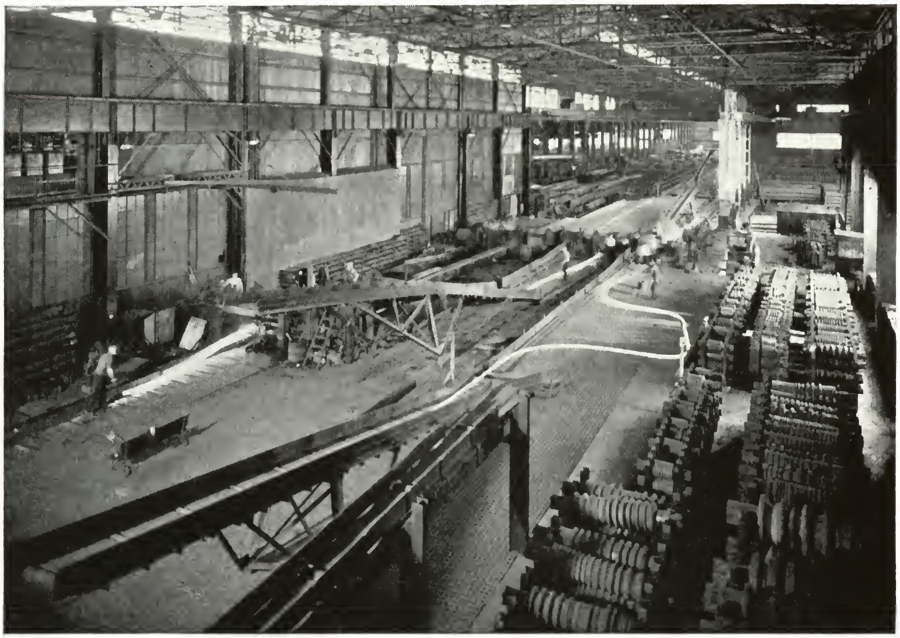
Top pouring ingot at the Los Angeles plant

Bottom pouring at the Seattle plant

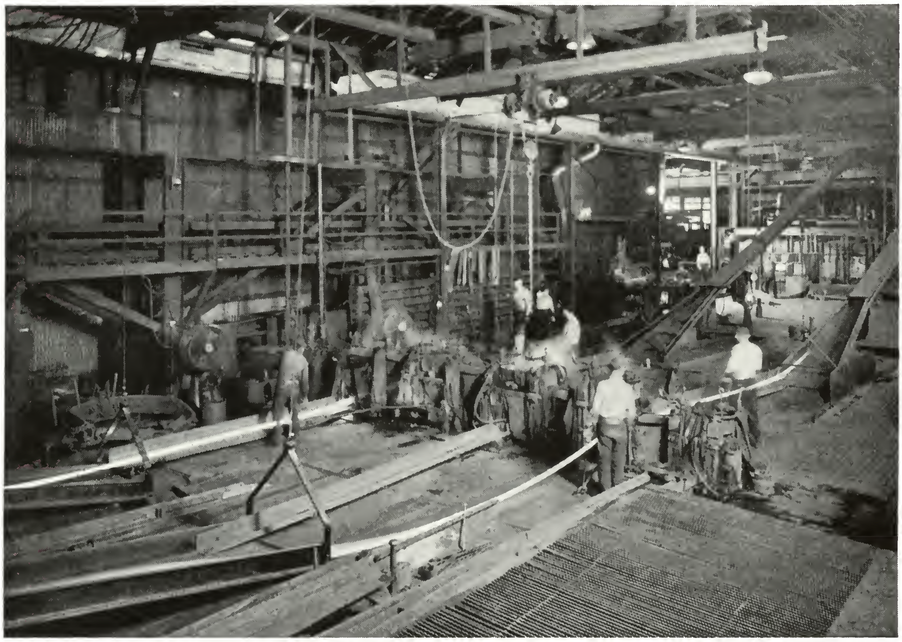
Section of chemical laboratory at the South San Francisco plant

Billet yard for small mill products at the South San Francisco plant

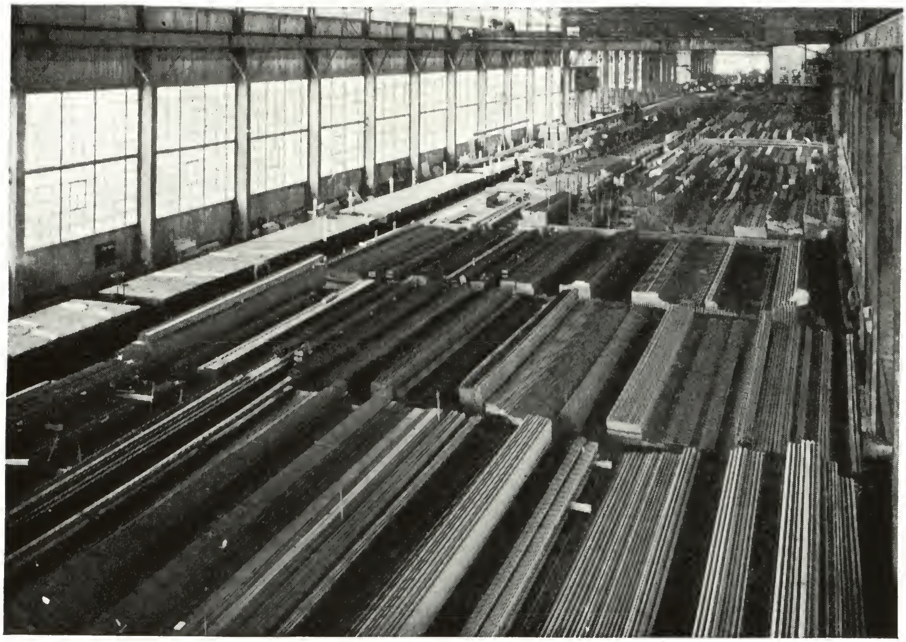
Rolling bars on the 24-inch and 18-inch mills at the South San Francisco plant



Rolling bars on the 16-inch and 12-inch mills at the South San Francisco plant



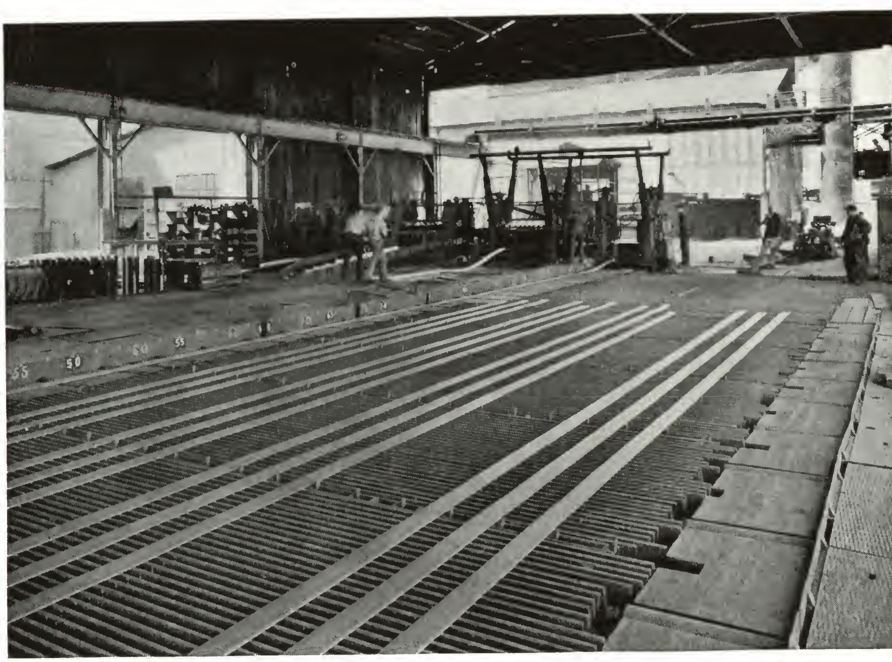
Rolling bars on the 9-inch mill at the South San Francisco plant



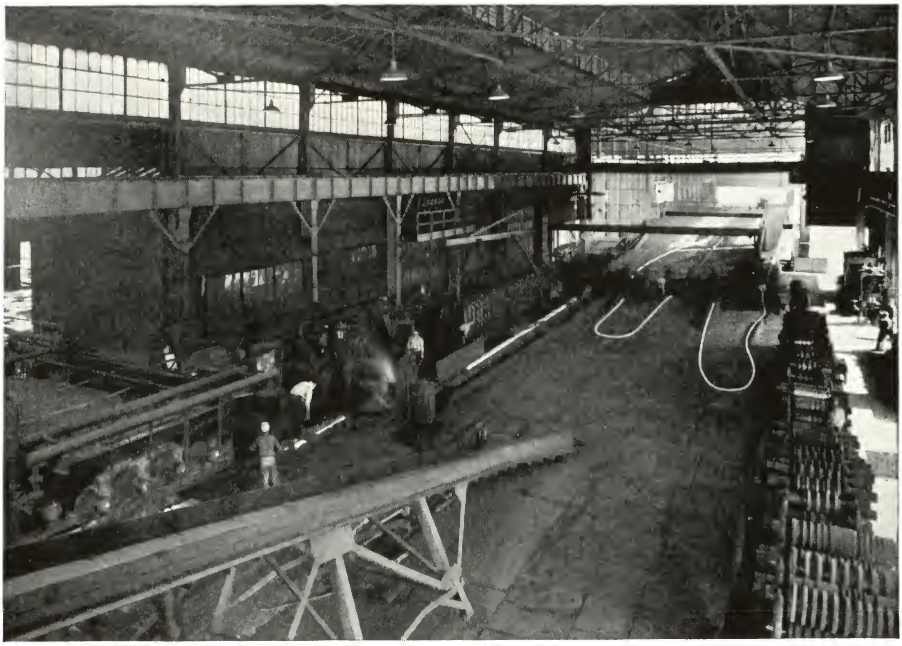
Storage bay for small mills products at the South San Francisco plant

Rolling bars on the 22-inch mill at the Seattle plant

Rolling bars on the 16-inch and 12-inch mills at the Seattle plant



Rolling bars on the 22-inch and 20-inch mills at the Los Angeles plant

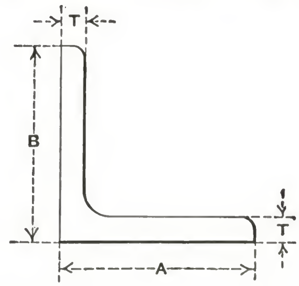


Rolling bars on the 16-inch and 12-inch mills at the Los Angeles plant

Shipping bay at the Los Angeles plant

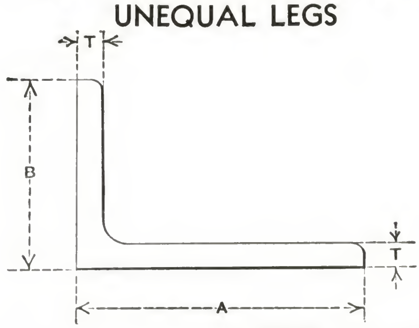
PACIFIC COAST SECTIONS

ANGLES—EQUAL LEGS



Section Number	SIZE A x B in.	3/32	No. 12 Gauge	1/8	3/16	1/4	5/16	3/8	7/16	1/2
		THICKNESS — T, IN INCHES								
		WEIGHT IN POUNDS PER LINEAR FOOT								
A 55	1/2 x 1/2	0.29	0.33	0.38	......	......	......	......	......	......
A 66	5/8 x 5/8	0.37	0.43	0.48	......	......	......	......	......	......
A 77	3/4 x 3/4	0.45	0.52	0.59	0.84	1.06	......	......	......	......
A 88	7/8 x 7/8	0.53	0.61	0.69	1.00	......	......	......	......	......
A 100	1 x 1	0.61	0.70	0.80	1.16	1.49	......	......	......	......
A 12	1 1/4 x 1 1/4	......	0.89	1.01	1.48	1.92	2.33	......	......	......
A 15	1 1/2 x 1 1/2	......	1.08	1.23	1.80	2.34	2.86	3.35	......	......
A 17	1 3/4 x 1 3/4	......	......	1.44	2.12	2.77	3.39	3.99	4.6	......
A 20	2 x 2	......	......	1.65	2.44	3.19	3.92	4.7	5.3	6.0
A 22	2 1/4 x 2 1/4	......	......	1.86	2.75	3.62	4.5	5.3	6.1	6.8
A 25	2 1/2 x 2 1/2	......	......	2.08	3.07	4.1	5.0	5.9	6.8	7.7

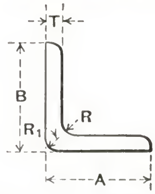
UNEQUAL LEGS



Section Number	SIZE A x B in.	1/8	3/16	1/4	5/16	3/8	7/16	1/2
		THICKNESS — T, IN INCHES						
		WEIGHT IN POUNDS PER LINEAR FOOT						
A 14	1 1/4 x 7/8	0.85	1.28	....	....	....	....	......
A 13	1 3/8 x 1 1/4	1.07	....	....	....	....	....	......
A 16	1 3/4 x 1 1/4	1.23	1.80	2.34	....	....	....	......
A 21	2 x 1 1/2	1.44	2.12	2.77	3.39	3.99	....	......
A 26	2 1/2 x 1 1/2	1.65	2.44	3.19	3.92	4.7	5.3	6.0
A 27	2 1/2 x 2	1.86	2.75	3.62	4.5	5.3	6.1	6.8

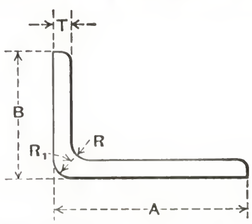
PACIFIC COAST SECTIONS

ANGLES — ROUND BACK EQUAL



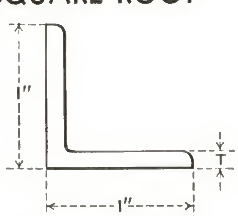
Section Number	SIZE A x B	Radius R	Radius R_1	THICKNESS — T, IN INCHES 3/32	No. 12 Gauge	1/8	5/32	3/16
	in.	in.	in.	WEIGHT IN POUNDS PER LINEAR FOOT				
A 770 R	3/4 x 3/4	1/8	1/8	0.45	0.53	0.59	0.71	0.84
A 880 R	7/8 x 7/8	1/8	1/8	....	0.62	0.69	0.85	1.00
A 100 R	1 x 1	1/8	1/8	....	0.70	0.80	0.98	1.16
A 120 R	1 1/4 x 1 1/4	3/16	5/32	....	....	1.01	1.24	1.48
A 150 R	1 1/2 x 1 1/2	3/16	5/32	....	....	1.23	1.52	....

ROUND BACK UNEQUAL



Section Number	SIZE A x B	Radius R	Radius R_1	THICKNESS — T, IN INCHES No. 12 Gauge	1/8	5/32	3/16	1/4
	in.	in.	in.	WEIGHT IN POUNDS PER LINEAR FOOT				
A 180 R	1 3/8 x 7/8	1/8	5/32	0.80	0.91	....	....	....
A 210 R	2 x 1 1/2	1/4	5/32	1.28	1.44	1.78	2.12	2.79

SQUARE ROOT

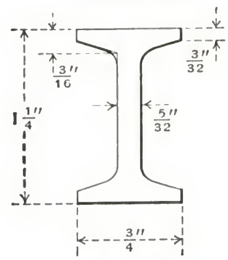


Section Number	THICKNESS T	Pounds per Foot
	in.	
A 103	1/8	0.79
A 103	3/16	1.14

PACIFIC COAST SECTIONS

BEAM

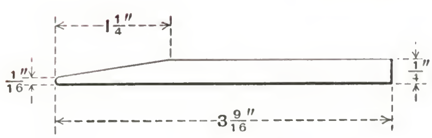
SPECIAL



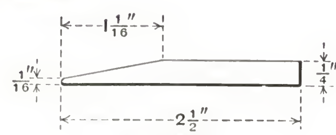
M 1388
1.25 Pounds per Foot

BEVELS

SINGLE BEVEL EDGE

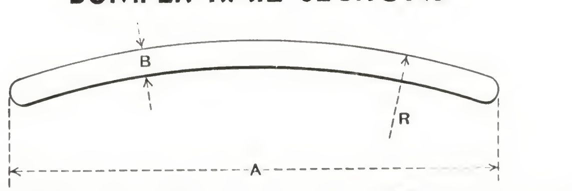


M 1690
2.76 Pounds per Foot



M 1691
1.91 Pounds per Foot

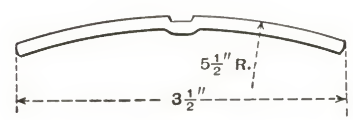
BUMPER RAIL SECTIONS



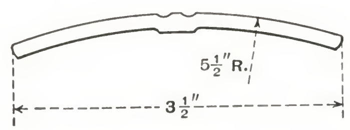
Section Number	DIMENSIONS IN INCHES			Pounds per Foot	Section Number	DIMENSIONS IN INCHES			Pounds per Foot
	A	B	R			A	B	R	
M 1433	3	1/8	5 1/2	1.30	M 1362	3 1/2	3/16	5 1/2	2.23
M 1433	3	3/16	5 1/2	1.91	M 1362	3 1/2	1/4	5 1/2	2.97
M 1433	3	1/4	5 1/2	2.55	M 1660	4 11/32	5/32	5 1/2	2.39
M 1524	3 1/4	5/32	5 1/2	1.66	M 1727	4 1/2	5/32	5 1/2	2.46
M 1362	3 1/2	1/8	5 1/2	1.51	M 1734	5	7/32	5 1/2	3.91
M 1362	3 1/2	5/32	5 1/2	1.82					

PACIFIC COAST SECTIONS

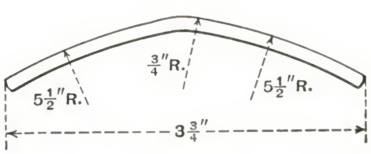
BUMPER RAIL SECTIONS



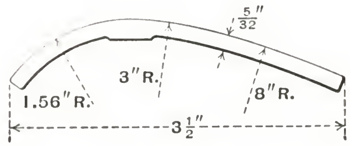
M 1517
1.92 Pounds per Foot



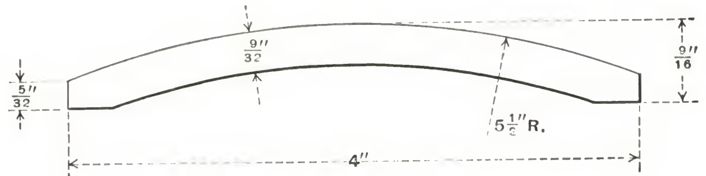
M 1649
1.92 Pounds per Foot



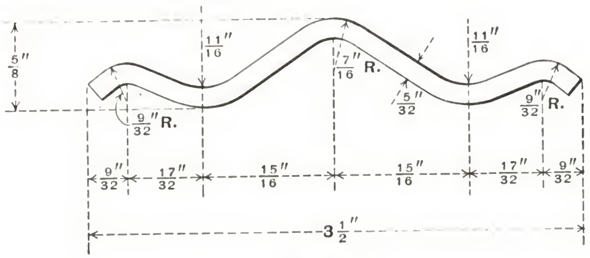
M 1659
2.13 Pounds per Foot



M 1757
2.17 Pounds per Foot



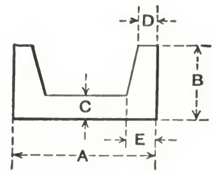
M 1432
3.82 Pounds per Foot



M 1475
2.09 Pounds per Foot

PACIFIC COAST SECTIONS

CHANNELS

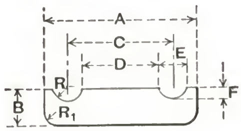


Section Number	DIMENSIONS IN INCHES					Pounds per Foot
	A	B	C	D	E	
SC 357	3/4	3/8	1/8	3/32	5/32	0.54
SC 357	3/4	7/16	3/16	3/32	5/32	0.72
SC 380	7/8	7/16	1/8	7/64	3/16	0.69
SC 380	7/8	1/2	3/16	7/64	3/16	0.88
SC 328	1	1/2	1/8	7/64	3/16	0.80
SC 328	1	9/16	3/16	7/64	3/16	1.04
SC 354	1 1/4	1/2	1/8	1/8	1/4	1.00
SC 354	1 1/4	9/16	3/16	1/8	1/4	1.28
SC 363	1 1/2	1/2	1/8	1/8	1/4	1.12
SC 363	1 1/2	9/16	3/16	1/8	1/4	1.44
SC 400	1 1/2	3/4	1/8	1/8	1/8	1.17
SC 381	1 3/4	7/16	1/8	5/32	1/4	1.18
SC 381	1 3/4	1/2	3/16	5/32	1/4	1.55
SC 399	2	1	3/16	7/32	1/4	2.57

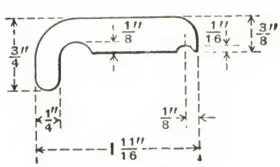
PACIFIC COAST SECTIONS

CLAMP SECTIONS

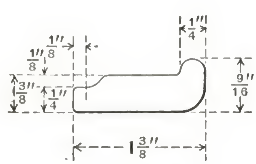
CABLE



Section Number	DIMENSIONS IN INCHES								Pounds per Foot
	A	B	C	D	E	F	R	R_1	
M 1395	$1\frac{9}{16}$	$\frac{3}{8}$	$\frac{7}{8}$	$\frac{9}{16}$	$\frac{5}{16}$	$\frac{1}{16}$	$\frac{7}{32}$	$\frac{1}{8}$	1.85
M 1397	$1\frac{9}{16}$	$\frac{3}{8}$	1	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{1}{8}$	1.80
M 1453	$1\frac{9}{16}$	$\frac{3}{8}$	$\frac{7}{8}$	$\frac{9}{16}$	$\frac{5}{16}$	$\frac{1}{16}$	$\frac{13}{64}$	$\frac{1}{8}$	1.87
M 1452	$1\frac{21}{32}$	$\frac{3}{8}$	$1\frac{5}{32}$	$\frac{25}{32}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{13}{64}$	$\frac{1}{8}$	1.84
M 1452	$1\frac{21}{32}$	.359	$1\frac{5}{32}$	$\frac{25}{32}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{13}{64}$	$\frac{1}{8}$	1.75
M 1008	$1\frac{21}{32}$	$\frac{3}{8}$	$1\frac{5}{32}$	$\frac{25}{32}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{8}$	1.89
M 1396	$1\frac{21}{32}$	$\frac{3}{8}$	$1\frac{11}{64}$	$\frac{13}{16}$	$\frac{23}{64}$	$\frac{3}{32}$	$\frac{13}{64}$	$\frac{1}{8}$	1.93
M 1398	$1\frac{3}{4}$	$\frac{3}{8}$	$1\frac{3}{16}$	$\frac{13}{16}$	$\frac{3}{8}$	$\frac{9}{64}$	$\frac{3}{16}$	$\frac{1}{8}$	2.04

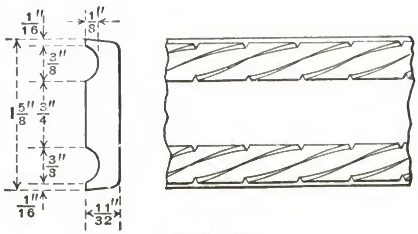


M 1317
2.12 Pounds per Foot

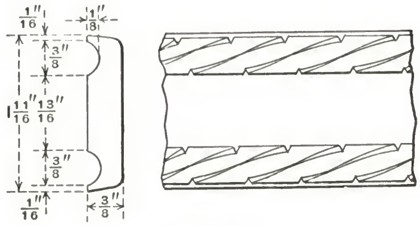


M 1318
1.74 Pounds per Foot

GUY



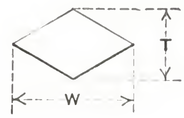
M 1430
1.76 Pounds per Foot



M 1431
1.85 Pounds per Foot

PACIFIC COAST SECTIONS

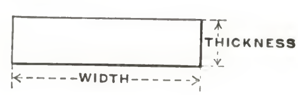
DIAMOND SECTIONS



Section Number	W	T	Pounds per Foot
	in.	in.	
M 1627	⅝	½	0.58
M 1628	⅞	⅝	0.96

FLATS

SQUARE EDGE



½″ to 1⅛″ wide x ¼″ to ¾″ thick
Over 1⅛″ to 1½″ wide x ¼″ to 1¼″ thick
Over 1½″ to 2¾″ wide x ¼″ to 1½″ thick
Over 2¾″ to 6″ wide x ¼″ to 2″ thick

Other sizes will be considered

For weights, see tables on pages 315 to 328

NUT FLATS

½″ x ¼″ to 3″ x 2⅛″

Other sizes will be considered

GEAR STOCK

⅞″ and 1⅛″ wide x ¾″ thick
1″ and 1¼″ wide x ¾″ and ⅞″ thick

STRIP

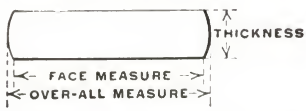
½″ to 1½″ wide x No. 12 Gage to 3/16″
Over 1½″ to 6″ wide x ⅛″ to 3/16″

Other sizes will be considered

PACIFIC COAST SECTIONS

FLATS

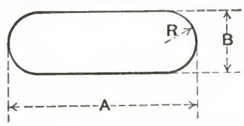
ROUND EDGE



1″ to 3″ wide x 3/16″ to 1″ thick   Over 3″ to 4″ wide x 1/4″ to 1″ thick
The above sizes can be furnished Face or Over-all Measure
The Over-all Measure is determined by adding to Face Measure:
One half of the thickness for all sizes up to 1/2″ inclusive in thickness
5/16″ for all sizes over 1/2″ to 3/4″ inclusive in thickness   3/8″ for all sizes over 3/4″ in thickness
Sizes not listed will be considered

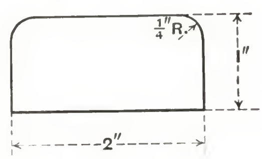
For weights, see tables on pages 331 to 340

FULL ROUND EDGE



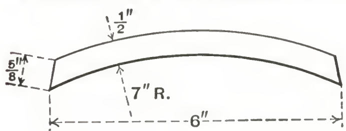
Section Number	DIMENSIONS IN INCHES			Pounds per Foot
	A	B	R	
M 1427	2	7/8	7/16	5.61
M 893	6	1 1/2	3/4	28.95

ROUND CORNER



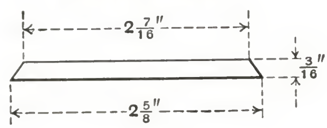
M 1428
6.50 Pounds per Foot

CONCAVE DOUBLE-BEVEL



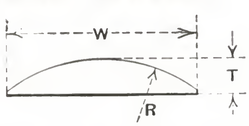
M 1550
10.20 Pounds per Foot

BEVEL-EDGE



M 1485
1.61 Pounds per Foot

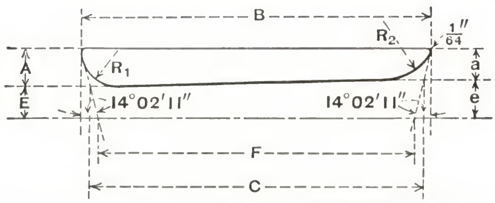
HALF OVALS



Section Number	DIMENSIONS IN INCHES			Pounds per Foot
	W	T	R	
M 1393	1 1/2	3/8	1	1.34
M 1394	1 3/4	7/16	1 5/32	1.82

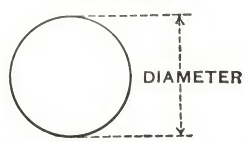
PACIFIC COAST SECTIONS

RAIL REINFORCING SECTIONS



Section Number	Type Rail	DIMENSIONS IN INCHES									Pounds per Foot
		A	a	B	C	E	e	F	R_1	R_2	
M 1421	110 AREA	13/32	11/32	3 3/4	3 9/16	11/32	13/32	3 13/32	3/8	5/8	4.42
M 1422	110 AREA	17/32	15/32	3 13/16	3 9/16	11/32	13/32	3 13/32	3/8	5/8	6.02
M 1423	110 AREA	25/32	23/32	3 15/16	3 9/16	11/32	13/32	3 13/32	3/8	5/8	9.31
M 1424	90 ARAA	13/32	11/32	3 31/64	3 19/64	5/16	25/64	3 5/32	3/8	3/8	4.21
M 1425	90 ARAA	17/32	15/32	3 55/64	3 19/64	5/16	25/64	3 5/32	3/8	3/8	5.70
M 1426	90 ARAA	25/32	23/32	3 43/64	3 19/64	5/16	25/64	3 5/32	3/8	3/8	8.60

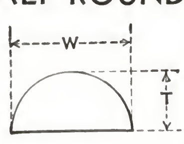
ROUNDS



1/4" to 1 7/16" dia., advancing by 64ths   Over 1 1/4" to 3" dia., advancing by 8ths
9/32" to 17/32" dia., advancing by 16ths   Over 3" to 3 1/2" dia., advancing by 4ths
Over 17/32" to 1 17/32" dia., advancing by 8ths   2 5/16", 4 1/4", 5 1/4", 6", 6 1/2", 6 3/4", 7", 7 1/4", 7 1/2"

Other sizes will be considered
Rounds can be furnished to decimal dimensions
For weights, see tables on pages 300 to 301

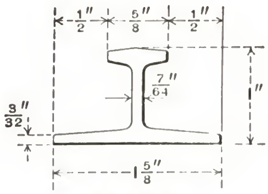
HALF ROUNDS



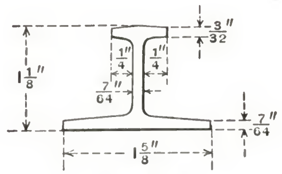
Section Number	W in.	T in.	Pounds per Foot
M 693	5/8	5/16	0.52
M 695	3/4	3/8	0.75
M 697	7/8	7/16	1.02
M 699	1	1/2	1.34
M 1391	1 1/4	5/8	2.09
M 701	1 1/2	3/4	3.00
M 1392	2 1/4	1 1/8	6.76

PACIFIC COAST SECTIONS

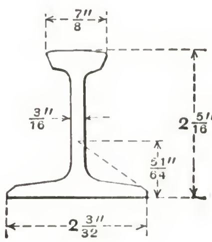
SASH AND CASEMENT SECTIONS



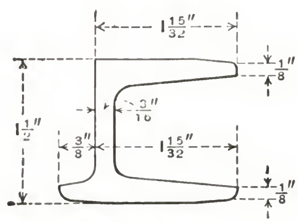
M 1414
1.31 Pounds per Foot



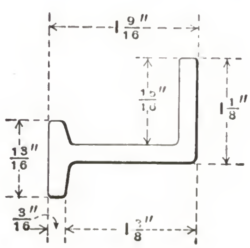
M 1404
1.35 Pounds per Foot



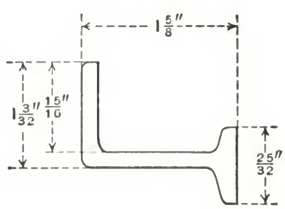
M 1416
4.10 Pounds per Foot



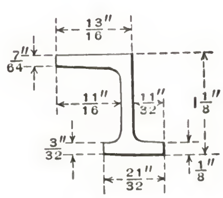
M 1408
2.91 Pounds per Foot



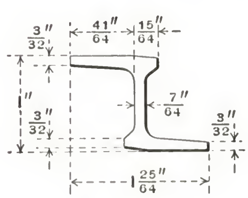
M 1523
2.00 Pounds per Foot



M 1406
1.85 Pounds per Foot



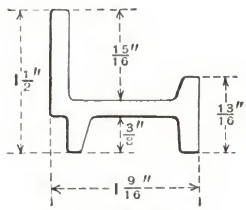
M 1403
1.05 Pounds per Foot



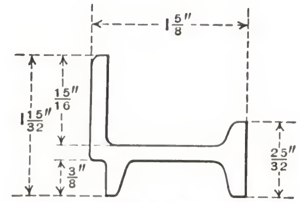
M 1415
1.04 Pounds per Foot

PACIFIC COAST SECTIONS

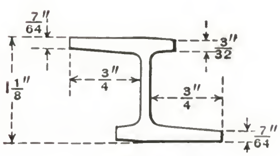
SASH AND CASEMENT SECTIONS



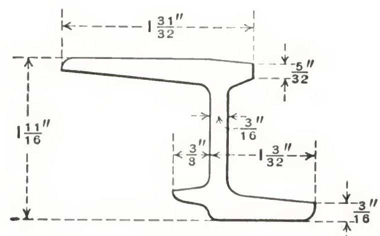
M 1521
2.33 Pounds per Foot



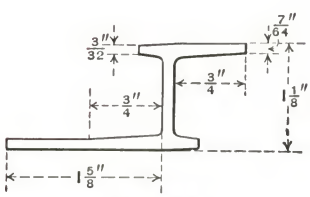
M 1405
2.15 Pounds per Foot



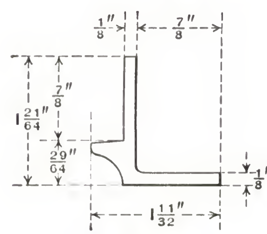
M 1402
1.31 Pounds per Foot



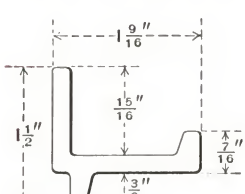
M 1409
3.28 Pounds per Foot



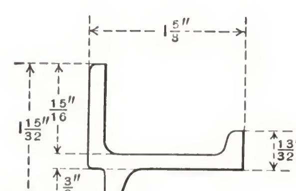
M 1413
1.68 Pounds per Foot



M 264
1.13 Pounds per Foot



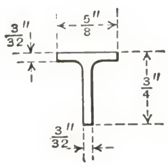
M 1522
2.00 Pounds per Foot



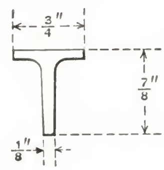
M 1407
1.85 Pounds per Foot

PACIFIC COAST SECTIONS

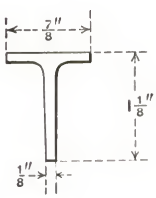
SASH AND CASEMENT SECTIONS



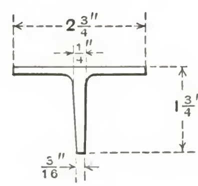
T 389
0.42 Pounds per Foot



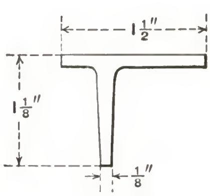
T 388
0.70 Pounds per Foot



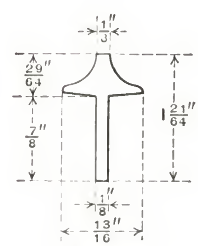
T 387
0.86 Pounds per Foot



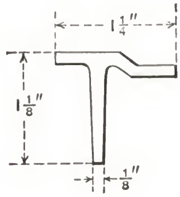
T 393
2.42 Pounds per Foot



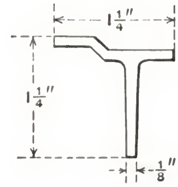
M 1401
1.12 Pounds per Foot



M 260
0.88 Pounds per Foot



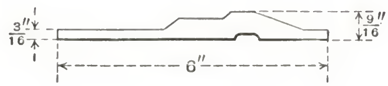
M 1400
0.98 Pounds per Foot



M 1399
0.98 Pounds per Foot

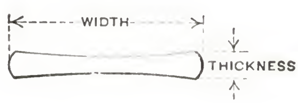
PACIFIC COAST SECTIONS

SPIGOT RING SECTION



M 1596
6.20 Pounds per Foot

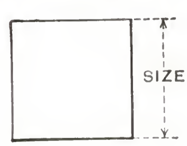
SPRING STEEL
ROUND EDGE CONCAVE



1" to 3" wide x 3/16" to 1" thick
Over 3" to 4" wide x 1/4" to 1" thick

Other sizes will be considered

SQUARES



1/4" to 5/8", advancing by 16ths, 37/64" and 41/64"
5/16" to 21/32", advancing by 32nds
Over 5/8" to 2 1/2", advancing by 8ths
Over 2 1/2" to 3 1/2", advancing by 4ths

Other sizes will be considered

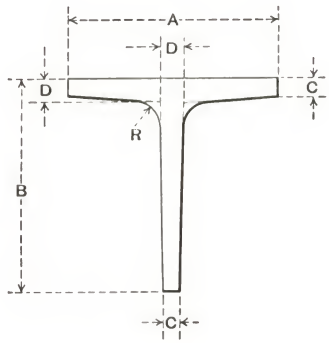
For weights, see tables on pages 300 and 301

SUCKER RODS

5/8", 3/4" and 7/8" diameter

PACIFIC COAST SECTIONS

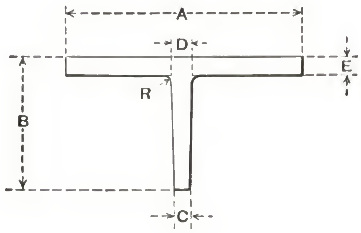
TEES—EQUAL



Section Number	DIMENSIONS IN INCHES					Pounds per Foot
	A	B	C	D	R	
T 5	1	1	1/8	5/32	1/8	0.89
T 392	1 1/4	1 1/4	3/16	7/32	1/8	1.59
T 374	1 1/2	1 1/2	1/8	5/32	3/16	1.31
T 191	1 1/2	1 1/2	3/16	7/32	3/16	1.94
T 375	2	2	3/16	9/32	1/4	3.01
T 37	2	2	1/4	5/16	1/4	3.56
T 47	2 1/2	2 1/2	1/4	5/16	1/4	4.60
T 49	2 1/2	2 1/2	5/16	3/8	1/4	5.53
T 376	2 1/2	2 1/2	3/8	7/16	1/4	6.40
T 377	3	3	1/4	5/16	5/16	5.50
T 378	3	3	5/16	3/8	5/16	6.70
T 379	3	3	3/8	7/16	5/16	7.80

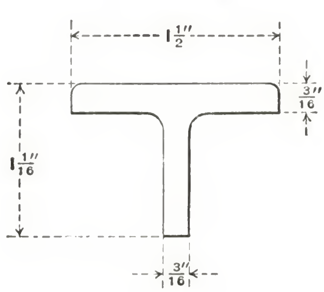
PACIFIC COAST SECTIONS

TEES—UNEQUAL



Section Number	DIMENSIONS IN INCHES						Pounds per Foot
	A	B	C	D	E	R	
T 389	5/8	3/4	3/32	3/32	3/32	3/32	0.42
T 388	3/4	7/8	1/8	1° to side	1/8	1/8	0.77
T 387	7/8	1 1/8	1/8	1° to side	1/8	1/8	0.86
T 380	1	1/2	3/32	7/64	3/32	1/16	0.44
T 381	2	2.46	3/16	7/32	7/32	1/4	3.13
T 382	2 1/2	1 3/8	3/16	7/32	3/16	1/16	2.41
T 383	2 1/2	1 23/32	3/16	7/32	3/16	1/16	2.60
T 393	2 3/4	1 3/4	3/16	1/4	1/8	3/16	2.42
T 384	3	2 7/16	7/32	1/4	3/16	1/4	3.80
T 385	3	2.52	7/32	1/4	9/32	1/4	4.75
T 386	3	1 3/4	3/16	7/32	3/16	1/16	2.98

SPECIAL



T 341
1.53 Pounds per Foot

PART 2

METALLURGICAL DATA AND USEFUL INFORMATION

CARBON STEELS

STEELS FOR SPECIFIC USES

TESTING AND PROPERTIES OF STEELS

WORKING OF STEEL

CARBON STEELS

IN the early development of the manufacture and use of steel, classification was based principally upon relative hardness, and the terms soft steel, dead soft steel, mild steel, medium steel, hard steel, and spring steel came into use.

Generally speaking, steels containing not over 0.20 per cent carbon and less than 0.60 per cent manganese were considered as being within the general classification of soft steels; dead soft steels were considered as those containing under 0.10 per cent carbon. Mild steels contained between approximately 0.15 and 0.25 per cent carbon and medium steels about 0.25 to 0.45 per cent carbon. Steels with a carbon content in the general range of 0.45 to 0.85 per cent were termed hard steels and those containing approximately 0.85 to 1.15 per cent carbon were referred to as spring steel grades.

While these older classifications were quite naturally of a rather general and indefinite character, they nevertheless served a useful purpose and even today, where a given use is not sufficiently restrictive to warrant closer definition by specified physical or chemical limitations, these descriptive terms may still be used.

Regardless of whether this older grading or one of the later methods of classification is used to describe steel, it is mutually advantageous for the user to give the steel maker complete information pertaining to further processing, use, and service conditions to which the steel will be subjected.

Steel is usually classed as carbon steel when the modifying elements of its chemical composition are limited to the constituents carbon, manganese, phosphorus, sulphur and silicon, also copper when specified. When the maximum amount of manganese exceeds 1.65 per cent or the maximum amount of silicon exceeds 1.00 per cent or the minimum of copper exceeds 0.40 per cent, the composition shall be considered as placing the steel outside the scope of this definition.

Carbon steels of the types covered by this book are:

Basic Open Hearth Steel
Acid Open Hearth Steel
Acid Bessemer Steel.

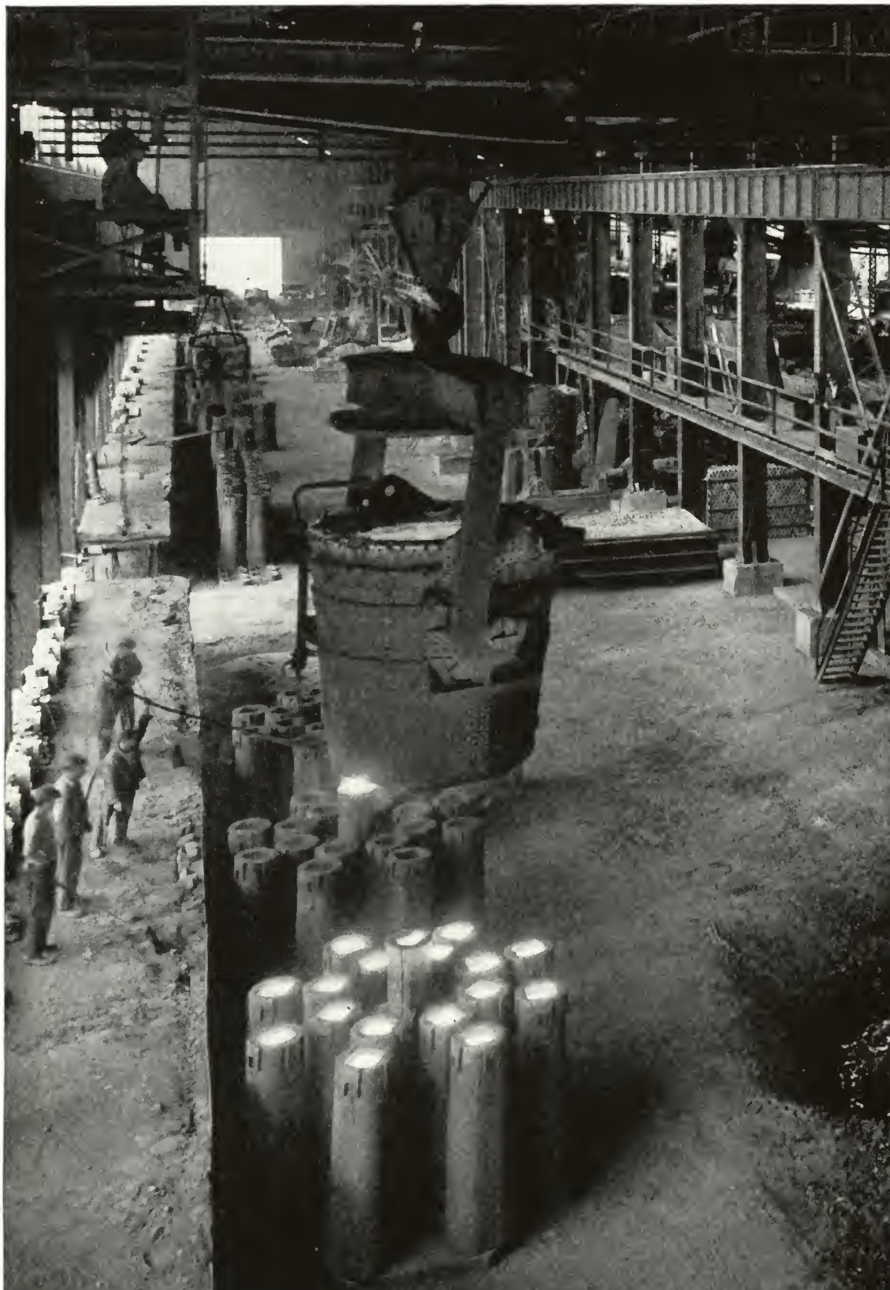
The greatest percentage of the steel discussed here is that made by the basic open hearth process. As far as tonnage is concerned, bessemer steel ranks next.

In the historical development of these processes, the bessemer converter was first used commercially, followed by the acid open hearth process, and that in turn by the basic open hearth process.

In this country bessemer steel is produced in acid lined converters, and the process does not eliminate phosphorus. Therefore the phosphorus content in this steel is dependent on the percentage of this element in the molten iron used. In many cases, this higher phosphorus content is not deleterious, and when combined with high sulphur, it has a distinct advantage for free-machining parts. Bessemer steel, mainly because of the phosphorus content, will be harder than basic open hearth steel of the same carbon and manganese content. This difference, as measured by increased tensile strength, will vary approximately between 4,000 and 15,000 pounds per square inch. This difference of strength is greatest in the lower carbon and manganese steels. The ductility will be correspondingly lower as compared with basic open hearth steel of the same carbon and manganese contents.

Acid open hearth steel normally contains considerably less phosphorus than acid bessemer steel. No phosphorus or sulphur is removed from the charge in the acid open hearth process, but the charge usually is made up of approximately 20 per cent pig iron and 80 per cent scrap. In the acid bessemer process, the entire charge is molten pig iron. In the acid open hearth process, selected low phosphorus and low sulphur pig iron is generally used. The content of these elements in the scrap is usually under 0.05 per cent. The average percentage of phosphorus and sulphur in the charge is, therefore, such that satisfactory steel can be furnished to specifications requiring a maximum of 0.05 per cent of each.

When making steel by the basic open hearth process the furnace has a lining of basic reacting materials. In general practice



Bottom pouring killed steel at the South San Francisco plant

Bottom pouring rimmed steel at the South San Francisco plant

the metal charge is about one-half pig iron, introduced either cold or in the molten condition, and the remainder scrap. In this process higher phosphorus and sulphur-bearing scrap can be consumed than in the acid process, due to the partial elimination of these elements by the basic slag reactions.

Basic open hearth steel is characteristically dependable in its physical properties, particularly in resistance to shock. It has the widest range of uses of all steels.

A division based upon the degree of deoxidation can be made in types of steel. The degree of deoxidation is controlled to produce steel having definite characteristics for specific purposes. This division distinguishes between rimmed steel and killed steel.

Killed steel, as the name suggests, has been deoxidized or killed before pouring so that it will be quiet when the metal is teemed into the ingot molds. Killed steel is usually teemed into molds which are provided with sink heads or hot tops to eliminate pipe and undue segregation in the portion of the ingot used. The resultant product is a steel of good uniformity, both structurally and chemically, over its cross section, after the top of the ingot including the hot top or sink head has been discarded. See photograph on page 255 of a cross section of a billet etched with hot acid.

Rimmed steel is intentionally made so that action will take place in the molds. This action, due to the liberation of gases during solidification, is controlled by very careful open hearth practice during the refining period of the heat. Only relatively low carbon and low manganese steels are rimmed, due to the quieting or killing influence of these elements. As the metal freezes progressively inward from the sides of the molds, the released gases cause an effervescing action, carrying the impurities to the top, which is open until solidification is complete. The resulting ingot has a thick outer body of tough, ductile metal, very low in carbon, as illustrated by the photograph on page 254 of a cross section of a billet that has been etched in hot acid.

In order to improve machinability some types of carbon steel are made with the manganese content above the usual range and sulphur that is considerably above normal. These steels, besides

possessing free-cutting properties, develop an excellent combination of physical qualities in the heat-treated condition.

High quality carbon steel, through advancements in the art of metallurgy, can now be used in many cases where heretofore alloy steels were considered necessary. The ability to produce deep or shallow hardening qualities greatly broadens the field for carbon steel. This relatively new method of classifying steel, in the case of heat-treated parts, is almost as important as chemical analysis and is assurance of consistent response to heat treatment.

Quality carbon steel that is made to meet special requirements receives the greatest care throughout in Bethlehem's steel plants. This constant supervision and checking, includes control of melting practice for both the metal and slag; temperature and rate of pouring; close and regulated temperatures in all hot-forming operations; special surface preparation; careful and rigid follow-up and inspection; application of the later tests for quality, such as hot acid etching, shear tests, fracture tests, hardenability tests, A.S.T.M. E19-33 tests and other special tests which, by their nature, simulate subsequent processing and service conditions.

The 1935 list of S. A. E. steels is given complete on pages 159 to 162. It is very significant that 35 types of steel are shown under Carbon and Free-Cutting Steels, while the previous list in 1933 included only 15 under these two headings. Much of the increase in the number of grades of carbon steels is due to the introduction of depth hardness requirements in addition to chemical composition.

It is noteworthy that in the lower carbon carburizing grades of steel provision has been made for higher manganese contents, and that in many of the higher carbon oil-hardening grades the manganese has been raised to 0.60 to 0.90 per cent. This provides an opportunity, in many cases, to use either deep or shallow hardening steels, as may be desired for the particular purpose. The higher manganese grades will overcome some of the shallower hardening characteristics of "fine-grained" steels according to the A.S.T.M. E19-33 test. The lower manganese types permit "coarse-grained" steels (A.S.T.M. E19-33) with their deeper hardening

and better machining characteristics, to be used without undue danger of cracking in treatment.

The S. A. E. series of analyses is generally recognized in the United States as the basis for numerical representation and division of ranges of chemical analysis of steels. Many users of carbon and special purpose steels have their own designations of chemical ranges, but in general, where a number of different ranges are involved, the S. A. E. grading is used as the basis.

In addition to the S. A. E. types, many other steels that are popular for special uses are produced at the Bethlehem mills.

The charts presented in the following pages show the physical properties of the various types of steel in the "as-rolled" or "natural," "annealed," "normalized," and "quenched and drawn" conditions.

It must be remembered, in making use of these data, that the results represent average physical properties. They are not the maximum obtainable, nor the minimum which may be anticipated. They are offered for guidance only.

It must be further understood that the size of the section has a pronounced effect on the physical properties and that these charts in every case represent results obtained from a 1-inch round bar in the condition designated at the bottom of each chart. The tensile strength tests were made by machining a 0.505 x 2-inch test bar from the axis of the bar. If the bar is tested in full size and the elongation is measured over eight inches, a lower percentage of elongation is naturally to be expected.

The Brinell, Rockwell and Scleroscope values shown on these charts are results of tests made on the tensile test bars and are therefore representative of the internal hardness rather than the surface or skin hardness.

Impact tests such as Izod or Charpy are available on request for these different type steels but have not been included in the charts because of the possibility of misinterpretation due to variations in making this test, such as the methods, degree of finish of notch, type of machine, etc.

Bethlehem produces all types of carbon steel and will gladly cooperate in assisting in the selection of the proper type for any of the uses for which carbon steel is suitable.

VISCOMETER

The Viscometer is used in the open hearth to determine the viscosity or fluidity of the slag, which has a general relation to its chemical composition. In this manner there is obtained in a few minutes, the approximate analysis of the slag, which is useful as a measure in controlling the degree of oxidation of the metal.

Slag for test being poured in a special mold.

Determining viscosity by measuring the distance of flow through a restricted hole in the mold.

CHECKING DEOXIDATION

Illustration showing the apparatus which is used in the test to determine quickly the relative degree of deoxidation of the metal in an open hearth furnace.

CARBOMETER

The Carbometer provides a quick method of determining the carbon content of the metal while steel is being made in the open hearth. During the "working period" its results serve as a guide for the additions of ore: During the "final period" they serve as a guide for arriving at the desired analysis. This test does not replace the ladle analysis made in the chemical laboratory in the usual manner.

Pouring steel sample into special mold after it has been deoxidized.

The next step is to part the split mold as soon as the metal is solidified and quench the sample in water.

Determining the carbon content of the sample in the apparatus by magnetic and electrical methods.

S. A. E. STEELS

Revised 1935

Carbon Steels

S.A.E. No.	C.	Mn.	P. (max.)	S. (max.)
1010	0.05–0.15	0.30–0.60	0.045	0.055
1015	0.10–0.20	0.30–0.60	0.045	0.055
X1015	0.10–0.20	0.70–1.00	0.045	0.055
1020	0.15–0.25	0.30–0.60	0.045	0.055
X1020	0.15–0.25	0.70–1.00	0.045	0.055
1025	0.20–0.30	0.30–0.60	0.045	0.055
X1025	0.20–0.30	0.70–1.00	0.045	0.055
1030	0.25–0.35	0.60–0.90	0.045	0.055
1035	0.30–0.40	0.60–0.90	0.045	0.055
1040	0.35–0.45	0.60–0.90	0.045	0.055
X1040	0.35–0.45	0.40–0.70	0.045	0.055
1045	0.40–0.50	0.60–0.90	0.045	0.055
X1045	0.40–0.50	0.40–0.70	0.045	0.055
1050	0.45–0.55	0.60–0.90	0.045	0.055
X1050	0.45–0.55	0.40–0.70	0.045	0.055
1055	0.50–0.60	0.60–0.90	0.040	0.055
X1055	0.50–0.60	0.90–1.20	0.040	0.055
1060	0.55–0.70	0.60–0.90	0.040	0.055
1065	0.60–0.75	0.60–0.90	0.040	0.055
X1065	0.60–0.75	0.90–1.20	0.040	0.055
1070	0.65–0.80	0.60–0.90	0.040	0.055
1075	0.70–0.85	0.60–0.90	0.040	0.055
1080	0.75–0.90	0.60–0.90	0.040	0.055
1085	0.80–0.95	0.60–0.90	0.040	0.055
1090	0.85–1.00	0.60–0.90	0.040	0.055
1095	0.90–1.05	0.25–0.50	0.040	0.055

Free-Cutting Steels

S.A.E. No.	C.	Mn.	P.	S.
1112	0.08–0.16	0.60–0.90	0.09–0.13	0.10–0.20
X1112	0.08–0.16	0.60–0.90	0.09–0.13	0.20–0.30
1115	0.10–0.20	0.70–1.00	0.045 max.	0.075–0.15
1120	0.15–0.25	0.60–0.90	0.045 max.	0.075–0.15
X1314	0.10–0.20	1.00–1.30	0.045 max.	0.075–0.15
X1315	0.10–0.20	1.30–1.60	0.045 max.	0.075–0.15
X1330	0.25–0.35	1.35–1.65	0.045 max.	0.075–0.15
X1335	0.30–0.40	1.35–1.65	0.045 max.	0.075–0.15
X1340	0.35–0.45	1.35–1.65	0.045 max.	0.075–0.15

S. A. E. STEELS

Revised 1935

Manganese Steels [1]

S.A.E. No.	C.	Mn.	P.(max.)	S.(max.)
T1330	0.25–0.35	1.60–1.90	0.040	0.050
T1335	0.30–0.40	1.60–1.90	0.040	0.050
T1340	0.35–0.45	1.60–1.90	0.040	0.050
T1345	0.40–0.50	1.60–1.90	0.040	0.050
T1350	0.45–0.55	1.60–1.90	0.040	0.050

Nickel Steels [1]

S.A.E. No.	C.	Mn.	P.(max.)	S.(max.)	Ni.
2015	0.10–0.20	0.30–0.60	0.040	0.050	0.40–0.60
2115	0.10–0.20	0.30–0.60	0.040	0.050	1.25–1.75
2315	0.10–0.20	0.30–0.60	0.040	0.050	3.25–3.75
2320	0.15–0.25	0.30–0.60	0.040	0.050	3.25–3.75
2330	0.25–0.35	0.50–0.80	0.040	0.050	3.25–3.75
2335	0.30–0.40	0.50–0.80	0.040	0.050	3.25–3.75
2340	0.35–0.45	0.60–0.90	0.040	0.050	3.25–3.75
2345	0.40–0.50	0.60–0.90	0.040	0.050	3.25–3.75
2350	0.45–0.55	0.60–0.90	0.040	0.050	3.25–3.75
2515	0.10–0.20	0.30–0.60	0.040	0.050	4.75–5.25

Nickel-Chromium Steels [1]

S.A.E. No.	C.	Mn.	P.(max.)	S.(max.)	Ni.	Cr.
3115	0.10–0.20	0.30–0.60	0.040	0.050	1.00–1.50	0.45–0.75
3120	0.15–0.25	0.30–0.60	0.040	0.050	1.00–1.50	0.45–0.75
3125	0.20–0.30	0.50–0.80	0.040	0.050	1.00–1.50	0.45–0.75
3130	0.25–0.35	0.50–0.80	0.040	0.050	1.00–1.50	0.45–0.75
3135	0.30–0.40	0.50–0.80	0.040	0.050	1.00–1.50	0.45–0.75
3140	0.35–0.45	0.60–0.90	0.040	0.050	1.00–1.50	0.45–0.75
X3140	0.35–0.45	0.60–0.90	0.040	0.050	1.00–1.50	0.60–0.90
3145	0.40–0.50	0.60–0.90	0.040	0.050	1.00–1.50	0.45–0.75
3150	0.45–0.55	0.60–0.90	0.040	0.050	1.00–1.50	0.45–0.75
3215	0.10–0.20	0.30–0.60	0.040	0.050	1.50–2.00	0.90–1.25
3220	0.15–0.25	0.30–0.60	0.040	0.050	1.50–2.00	0.90–1.25
3230	0.25–0.35	0.30–0.60	0.040	0.050	1.50–2.00	0.90–1.25
3240	0.35–0.45	0.30–0.60	0.040	0.050	1.50–2.00	0.90–1.25
3245	0.40–0.50	0.30–0.60	0.040	0.050	1.50–2.00	0.90–1.25
3250	0.45–0.55	0.30–0.60	0.040	0.050	1.50–2.00	0.90–1.25
3312	0.17 max.	0.30–0.60	0.040	0.050	3.25–3.75	1.25–1.75
3325	0.20–0.30	0.30–0.60	0.040	0.050	3.25–3.75	1.25–1.75
3335	0.30–0.40	0.30–0.60	0.040	0.050	3.25–3.75	1.25–1.75
3340	0.35–0.45	0.30–0.60	0.040	0.050	3.25–3.75	1.25–1.75
3415	0.10–0.20	0.30–0.60	0.040	0.050	2.75–3.25	0.60–0.95
3435	0.30–0.40	0.30–0.60	0.040	0.050	2.75–3.25	0.60–0.95
3450	0.45–0.55	0.30–0.60	0.040	0.050	2.75–3.25	0.60–0.95

[1] Silicon range of all S. A. E. basic open hearth alloy steels shall be 0.15 to 0.30 per cent. For electric and acid open hearth alloy steels the silicon content shall be 0.15 per cent min.

S. A. E. STEELS

Revised 1935

Molybdenum Steels [1]

S.A.E. No.	C.	Mn.	P.(max.)	S.(max.)	Ni.	Cr.	Mo.
4130	0.25–0.35	0.50–0.80	0.040	0.050	....	0.50–0.80	0.15–0.25
X4130	0.25–0.35	0.40–0.60	0.040	0.050	....	0.80–1.10	0.15–0.25
4135	0.30–0.40	0.60–0.90	0.040	0.050	....	0.80–1.10	0.15–0.25
4140	0.35–0.45	0.60–0.90	0.040	0.050	....	0.80–1.10	0.15–0.25
4150	0.45–0.55	0.60–0.90	0.040	0.050	....	0.80–1.10	0.15–0.25
4340	0.35–0.45	0.50–0.80	0.040	0.050	1.50–2.00	0.50–0.80	0.30–0.40
4345	0.40–0.50	0.50–0.80	0.040	0.050	1.50–2.00	0.60–0.90	0.15–0.25
4615	0.10–0.20	0.40–0.70	0.040	0.050	1.65–2.00	....	0.20–0.30
4620	0.15–0.25	0.40–0.70	0.040	0.050	1.65–2.00	....	0.20–0.30
4640	0.35–0.45	0.50–0.80	0.040	0.050	1.65–2.00	....	0.20–0.30
4815	0.10–0.20	0.40–0.60	0.040	0.050	3.25–3.75	....	0.20–0.30
4820	0.15–0.25	0.40–0.60	0.040	0.050	3.25–3.75	....	0.20–0.30

Chromium Steels [1]

S.A.E. No.	C.	Mn.	P.(max.)	S.(max.)	Cr.
5120	0.15–0.25	0.30–0.60	0.040	0.050	0.60–0.90
5140	0.35–0.45	0.60–0.90	0.040	0.050	0.80–1.10
5150	0.45–0.55	0.60–0.90	0.040	0.050	0.80–1.10
52100	0.95–1.10	0.20–0.50	0.030	0.035	1.20–1.50

Chromium-Vanadium Steels [1]

S.A.E. No.	C.	Mn.	P.(max.)	S.(max.)	Cr.	Vanadium min.	Vanadium desired
6115	0.10–0.20	0.30–0.60	0.040	0.050	0.80–1.10	0.15	0.18
6120	0.15–0.25	0.30–0.60	0.040	0.050	0.80–1.10	0.15	0.18
6125	0.20–0.30	0.60–0.90	0.040	0.050	0.80–1.10	0.15	0.18
6130	0.25–0.35	0.60–0.90	0.040	0.050	0.80–1.10	0.15	0.18
6135	0.30–0.40	0.60–0.90	0.040	0.050	0.80–1.10	0.15	0.18
6140	0.35–0.45	0.60–0.90	0.040	0.050	0.80–1.10	0.15	0.18
6145	0.40–0.50	0.60–0.90	0.040	0.050	0.80–1.10	0.15	0.18
6150	0.45–0.55	0.60–0.90	0.040	0.050	0.80–1.10	0.15	0.18
6195	0.90–1.05	0.20–0.45	0.030	0.035	0.80–1.10	0.15	0.18

Tungsten Steels [1]

S.A.E. No.	C.	Mn.(max.)	P.(max.)	S.(max.)	Cr.	W.
71360	0.50–0.70	0.30	0.035	0.040	3.00–4.00	12.00–15.00
71660	0.50–0.70	0.30	0.035	0.040	3.00–4.00	15.00–18.00
7260	0.50–0.70	0.30	0.035	0.040	0.50–1.00	1.50– 2.00

[1] Silicon range of all S. A. E. basic open hearth alloy steels shall be 0.15 to 0.30 per cent. For electric and acid open hearth alloy steels the silicon content shall be 0.15 per cent min.

S. A. E. STEELS

Revised 1935

Silico-Manganese Steels

S.A.E. No.	C.	Mn.	P.(max.)	S.(max.)	Si.
9255	0.50-0.60	0.60-0.90	0.040	0.050	1.80-2.20
9260	0.55-0.65	0.60-0.90	0.040	0.050	1.80-2.20

Corrosion and Heat-Resisting Alloys

S.A.E. No.	C.(max.)	Mn.(max.)	P.(max.)	S.(max.)	Si.(max.)	Nickel	Chromium
30905	0.08	0.20-0.70	0.030	0.030	0.75	8.00-10.00	17.00-20.00
30915	0.09-0.20	0.20-0.70	0.030	0.030	0.75	8.00-10.00	17.00-20.00
51210	0.12	0.60	0.030	0.030	0.50	....	11.50-13.00
X51410	0.12	0.60	0.030	0.15-0.50	0.50	....	13.00-15.00
51335	0.25-0.40	0.60	0.030	0.030	0.50	....	12.00-14.00
51510	0.12	0.60	0.030	0.030	0.50	....	14.00-16.00
51710	0.12	0.60	0.030	0.030	0.50	....	16.00-18.00

S. A. E. RECOMMENDED HEAT TREATMENT (Revised 1935)

S.A.E. No.	Treatment Number	Normalize	Anneal	Quench	Draw
1025, X1025, 1030	I	....	......	1575-1650 H_2O	To desired hardness
	II	1700-1800-M	......	1575-1650 H_2O	To desired hardness
1035, 1040, X1040	I	....	......	1525-1575 oil or H_2O	To desired hardness
	II	1650-1750-M	......	1525-1575 oil or H_2O	To desired hardness
1045, X1045, 1050, X1050	I	....	......	1450-1550 oil or H_2O	To desired hardness
	II	1600-1700	......	1475-1525 oil or H_2O	To desired hardness
1055	I	Yes, or	Yes-M	1450-1550 oil or H_2O	To desired hardness
X1055	I	Yes, or	Yes-M	1500-1550 oil	To desired hardness
1060, 1065, X1065, 1070	I	Yes, or	Yes-M	1450-1550 oil	To desired hardness
1075	I	Yes, or	Yes-M	1450-1500 oil	To desired hardness
1080	I	Yes	Yes-M	1450-1500 oil	To desired hardness
1085	I	Yes	Yes-M	1400-1500 oil	To desired hardness
1090, 1095	I	Yes	Yes-M	1430-1500 oil, H_2O, brine	To desired hardness
	II*	....	......	1500-1600 oil	750-900
X1330	I	....	......	1525-1575 oil or H_2O	To desired hardness
	II	1650-1750-M	......	1525-1575 oil or H_2O	To desired hardness
X1335, X1340	I	....	......	1500-1550 oil or H_2O	To desired hardness
	II	1650-1750-M	......	1500-1550 oil or H_2O	To desired hardness

*For leaf springs.

When preference is given in quenching media the shape and section shall be the deciding factor.

M = Machine.

For carburizing or activated bath treatments of S. A. E. 1010, 1015, X1015, 1020, X1020, 1025, X1025, 1030, 1112, 1115, 1120, X1314 and X1315, see article on Carburizing Steels, page 180.

PHYSICAL PROPERTIES CHART

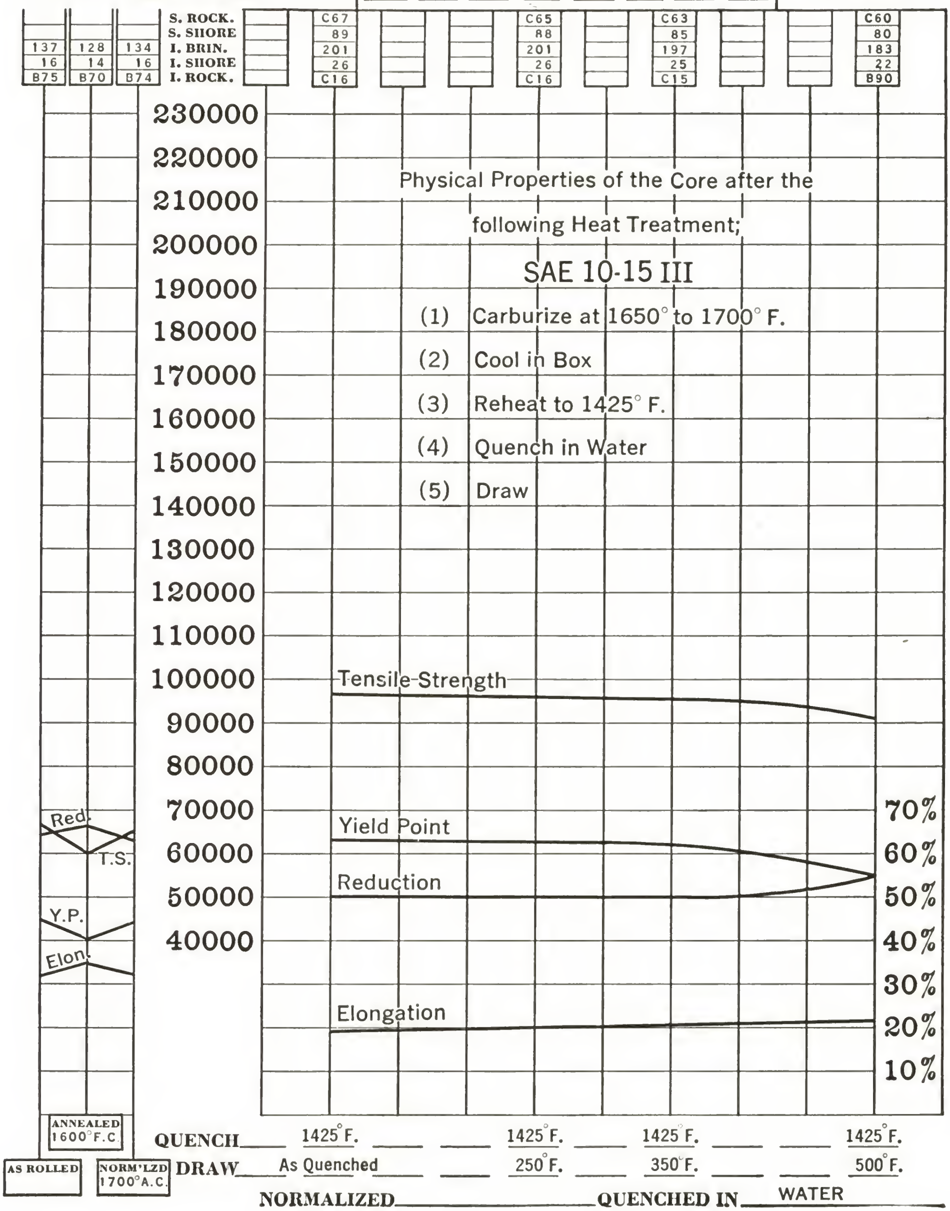
S. A. E. 10-15

(Average Values)

1" Dia. SIZE TREATED
.505"x 2" SIZE TESTED

C.	Mn.	P.	S.	Si.	Ni.	Cr.	V.
.10/.20	.30/.60	.045	.055				

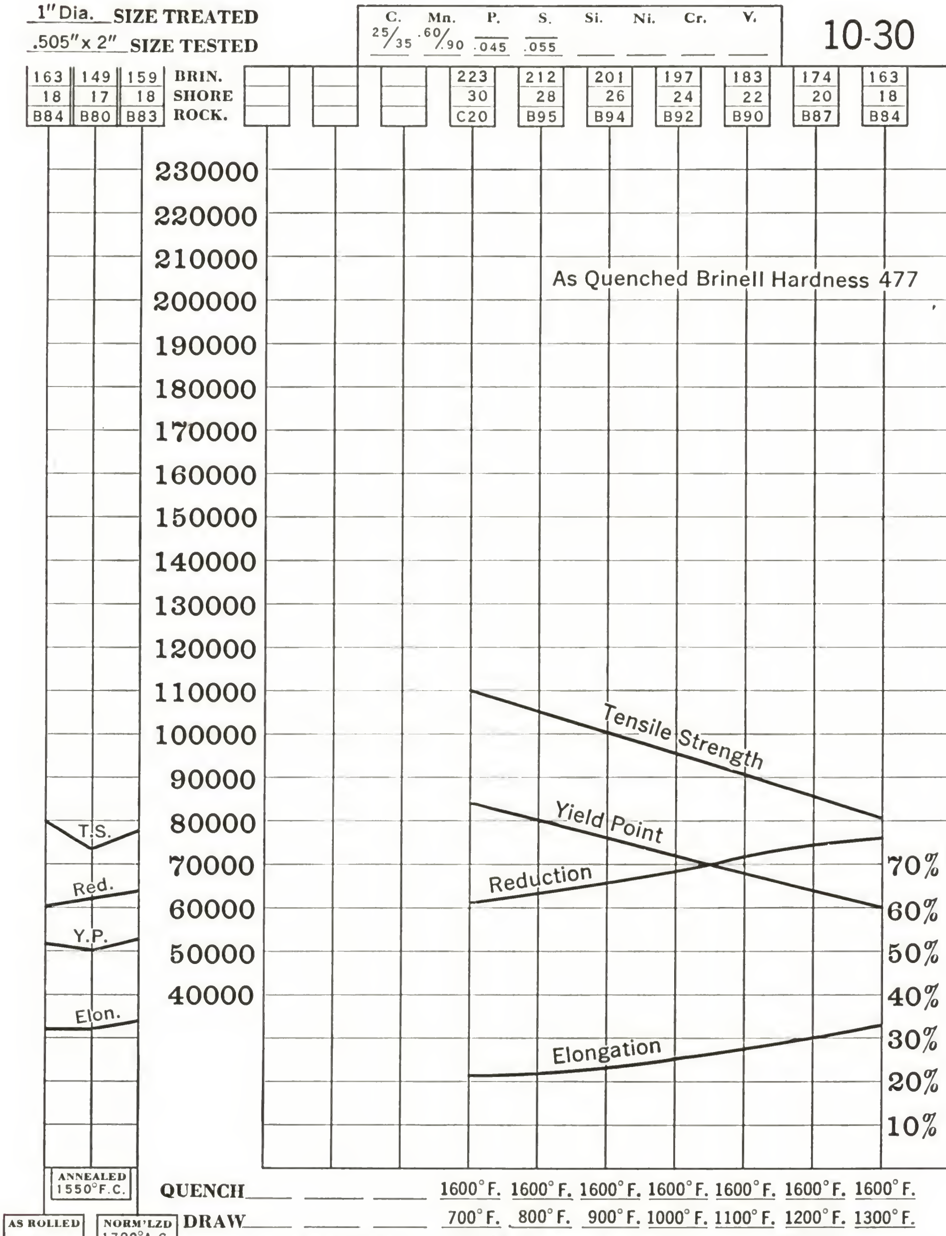
10-15



PHYSICAL PROPERTIES CHART

S. A. E. 10 - 30

(Average Values)



PHYSICAL PROPERTIES CHART

S. A. E. 10-40

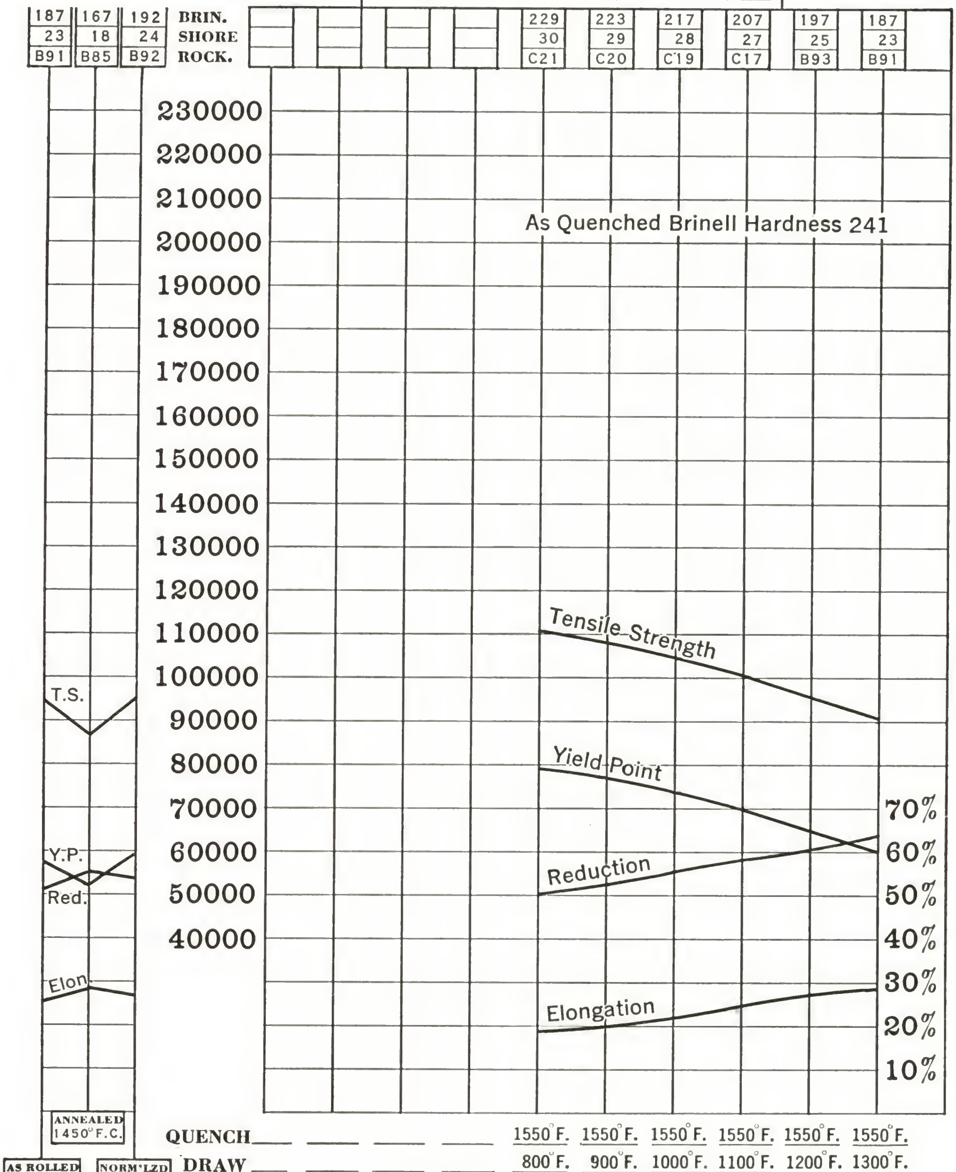
(Average Values)

1" Dia. SIZE TREATED

.505" x 2" SIZE TESTED

C.	Mn.	P.	S.	Si.	Ni.	Cr.	V.
.35/.45	.60/.90	.045	.055				

10-40

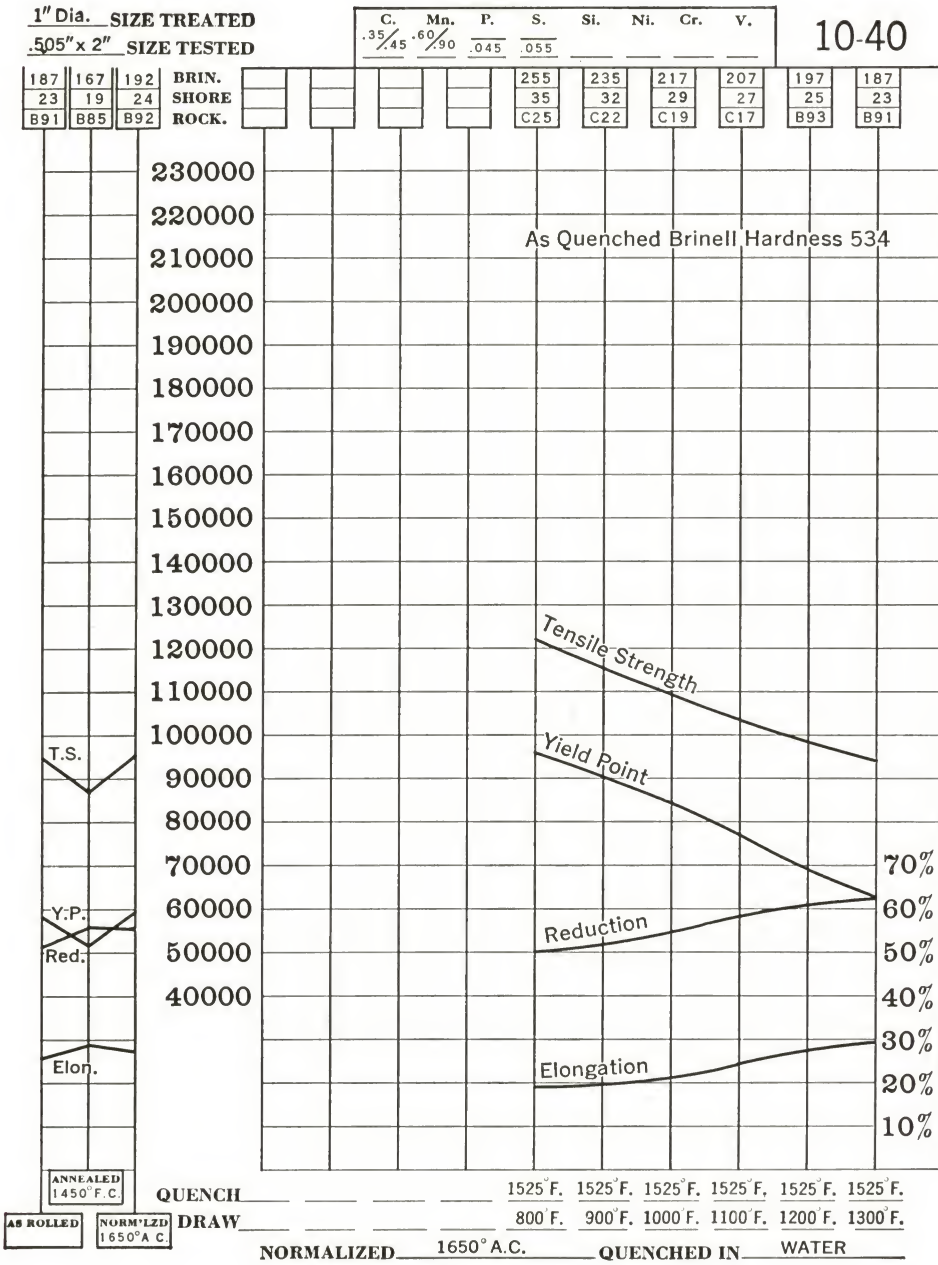


NORMALIZED 1650° A.C. QUENCHED IN OIL

PHYSICAL PROPERTIES CHART

S. A. E. 10 - 40

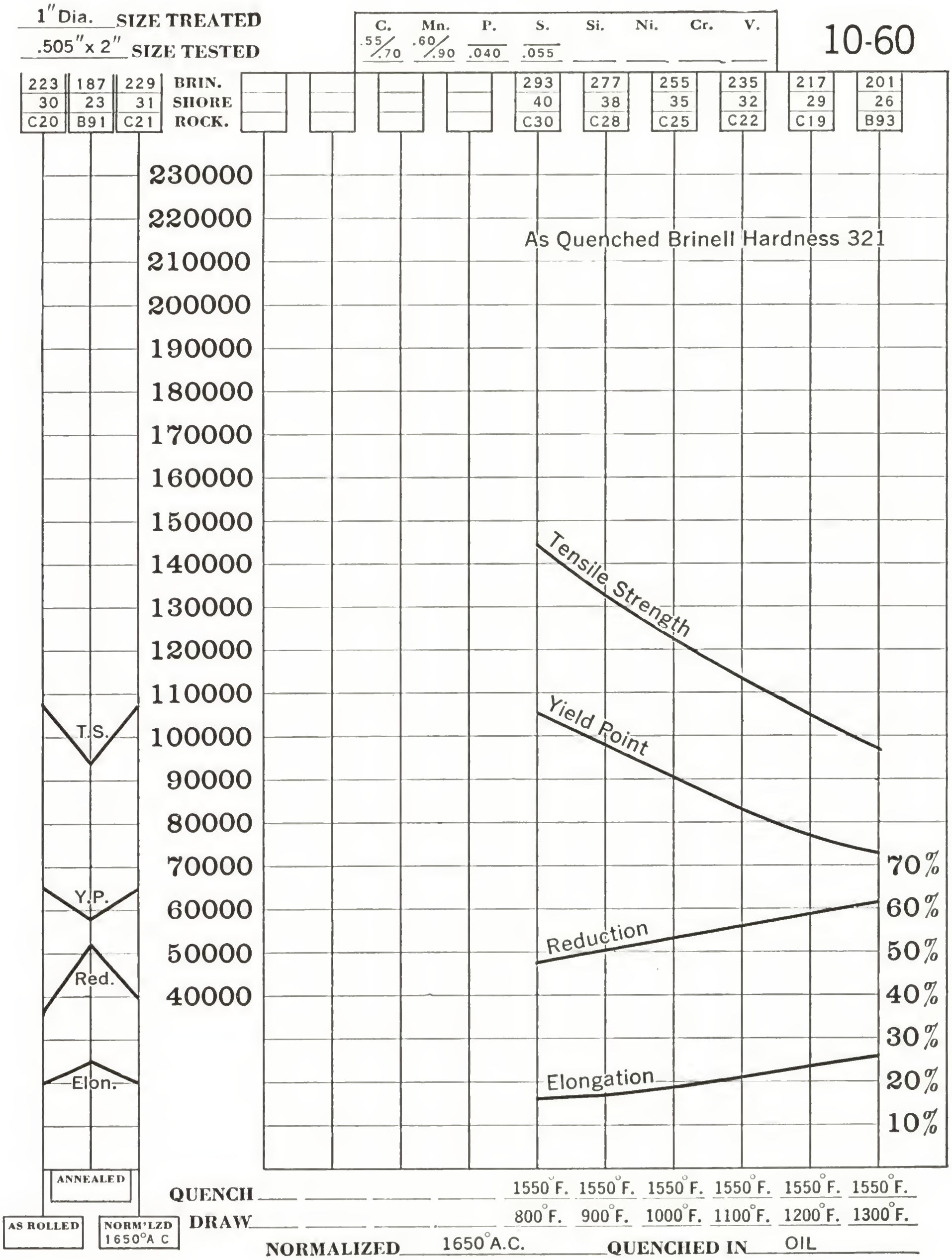
(Average Values)



PHYSICAL PROPERTIES CHART

S. A. E. 10-60

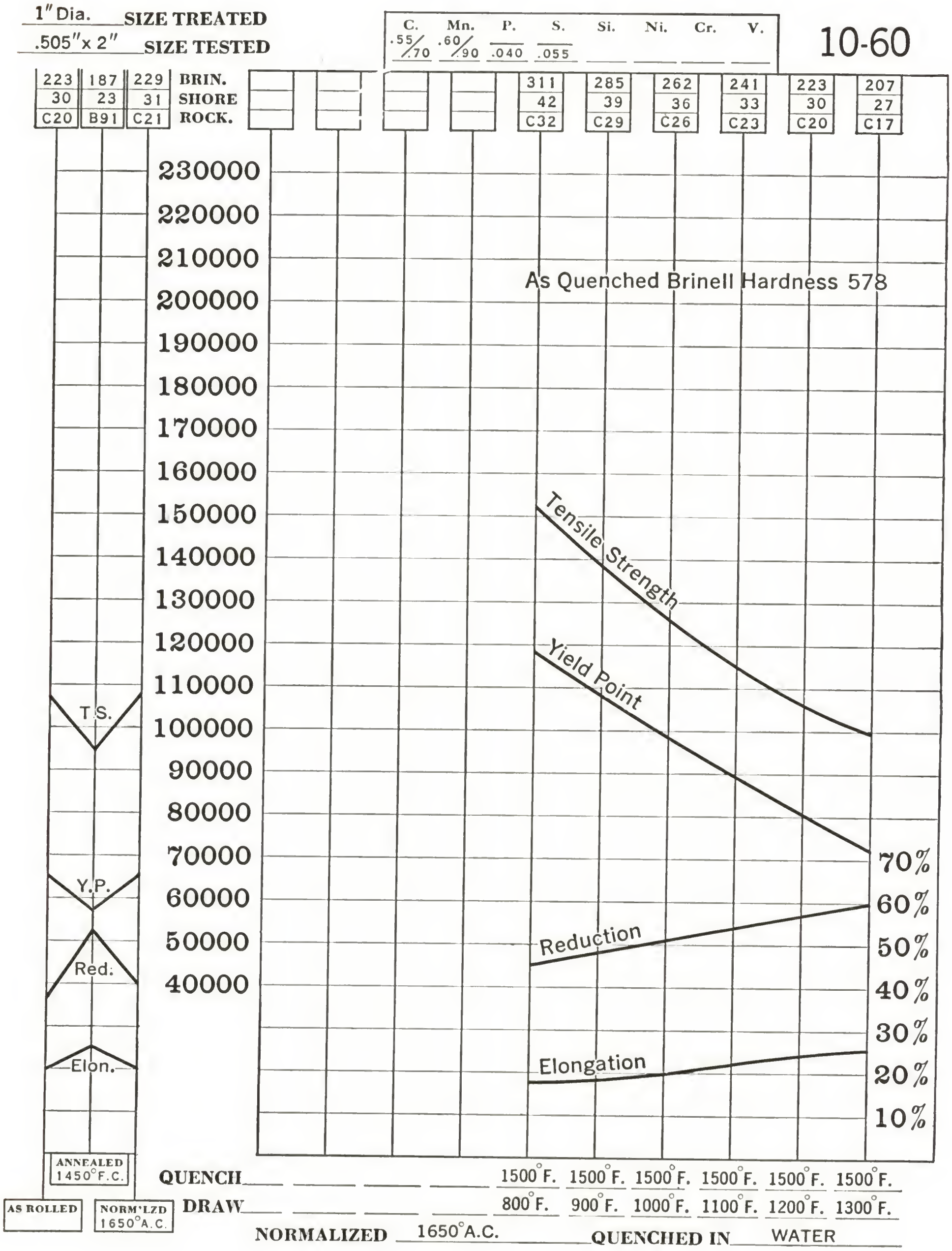
(Average Values)



PHYSICAL PROPERTIES CHART

S. A. E. 10 - 60

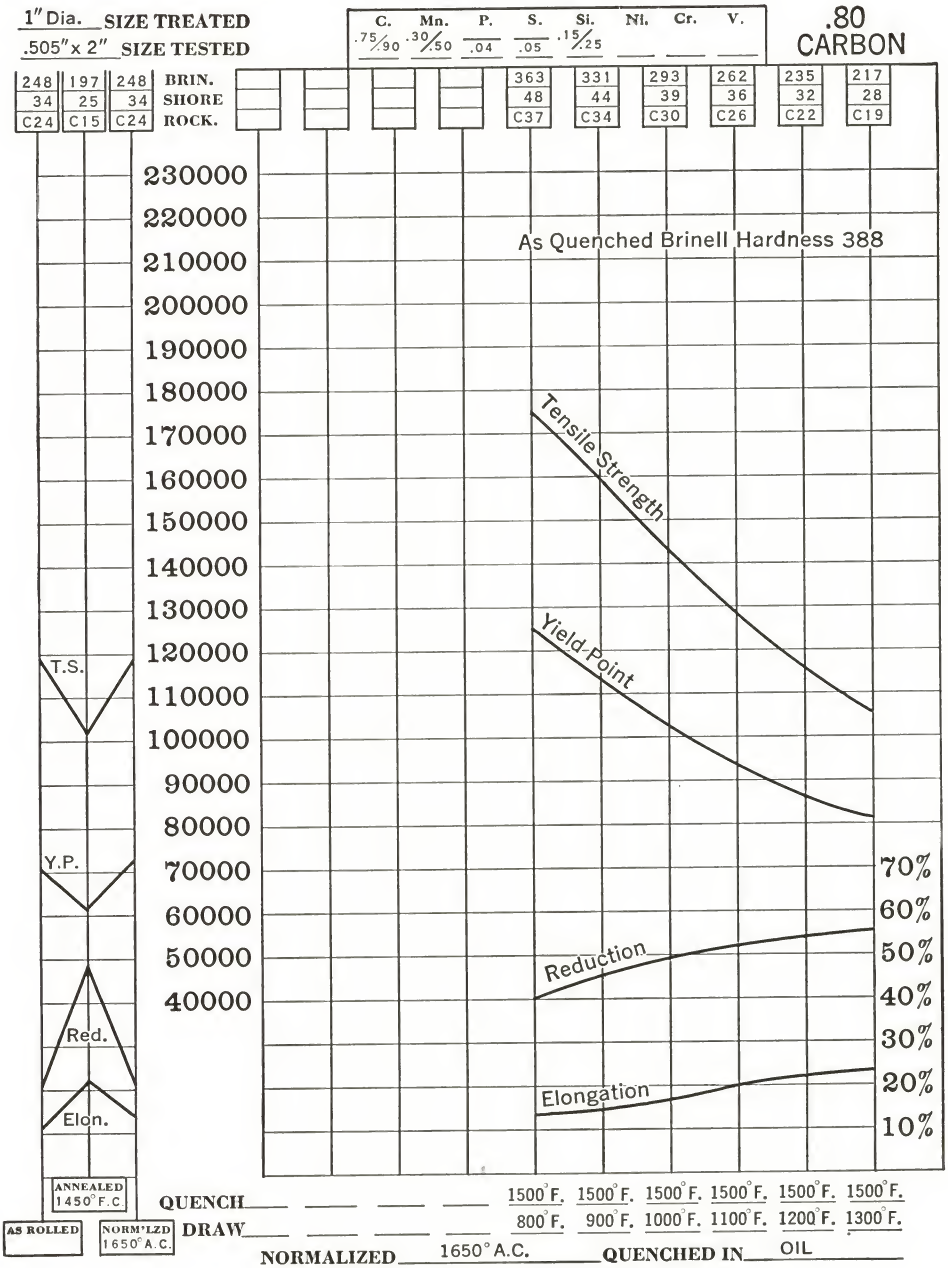
(Average Values)



PHYSICAL PROPERTIES CHART

.80 CARBON STEEL

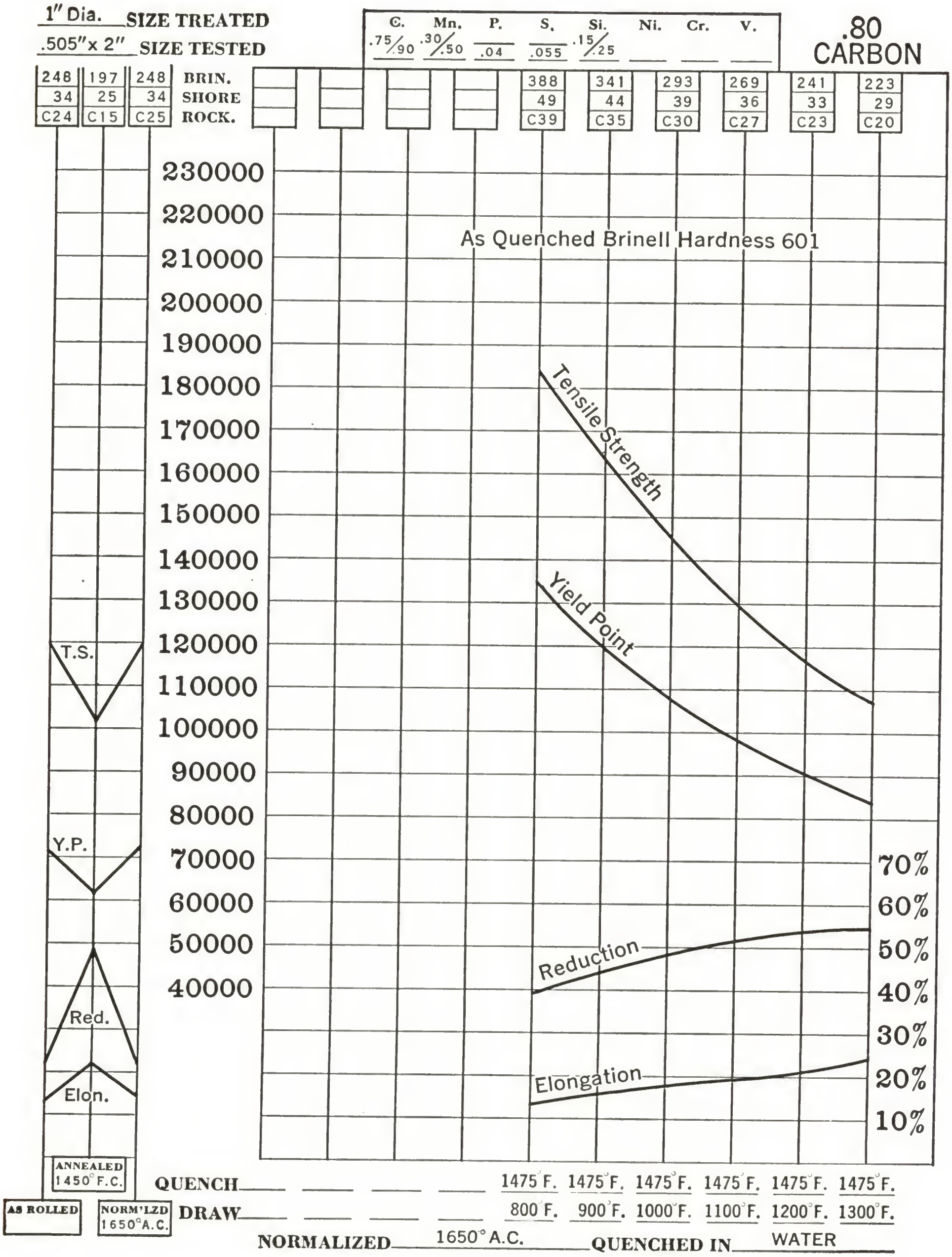
(Average Values)



PHYSICAL PROPERTIES CHART

.80 CARBON STEEL

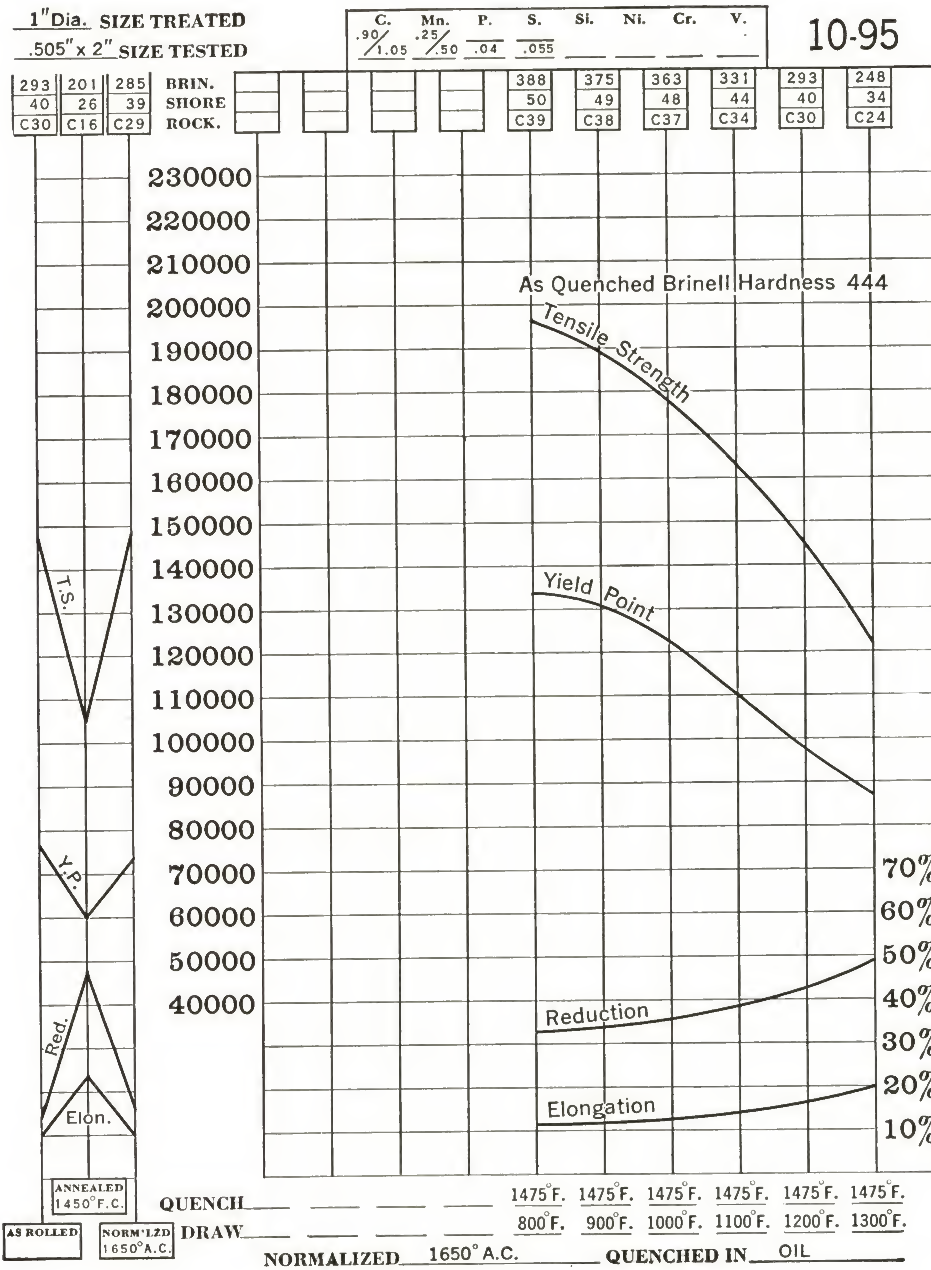
(Average Values)



PHYSICAL PROPERTIES CHART

S. A. E. 10 - 95

(Average Values)



PHYSICAL PROPERTIES CHART

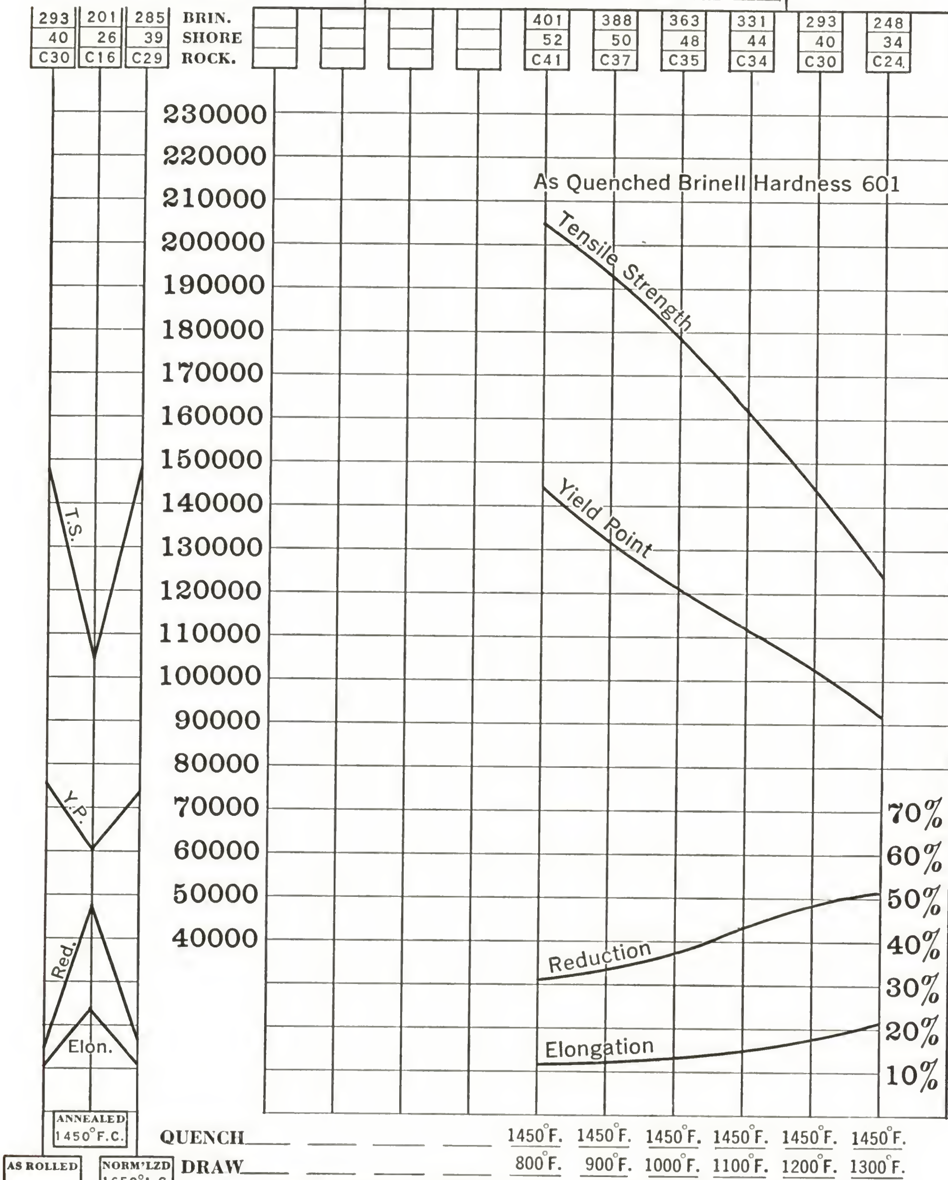
S. A. E. 10-95

(Average Values)

1" Dia. SIZE TREATED
.505" x 2" SIZE TESTED

C.	Mn.	P.	S.	Si.	Ni.	Cr.	V.
.90/1.05	.25/.50	.04	.055				

10-95



QUENCH ___ ___ ___ ___ 1450°F. 1450°F. 1450°F. 1450°F. 1450°F. 1450°F.

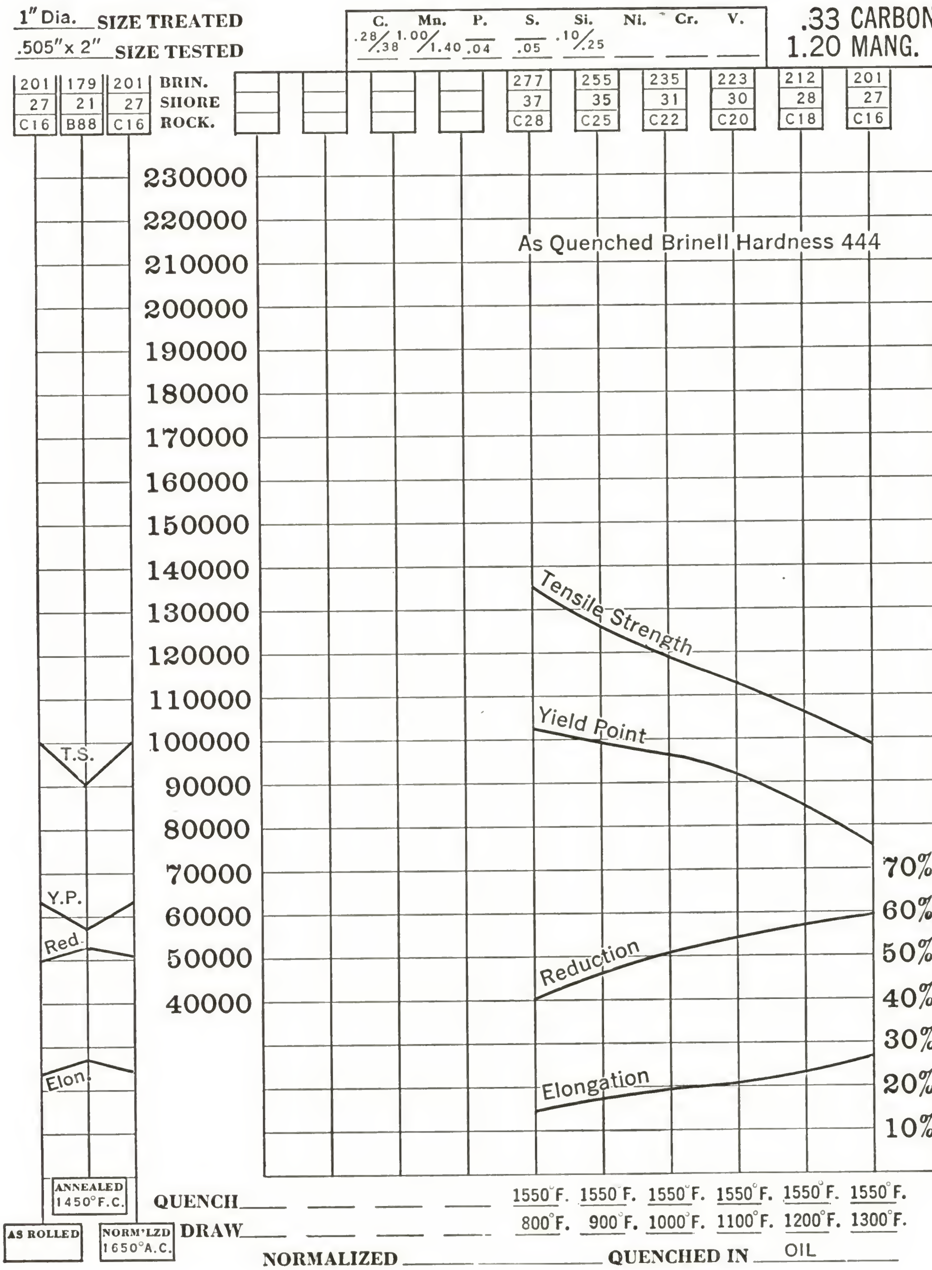
DRAW ___ ___ ___ ___ 800°F. 900°F. 1000°F. 1100°F. 1200°F. 1300°F.

NORMALIZED 1650° A.C. QUENCHED IN WATER

PHYSICAL PROPERTIES CHART

.33 CARBON, 1.20 MANGANESE STEEL

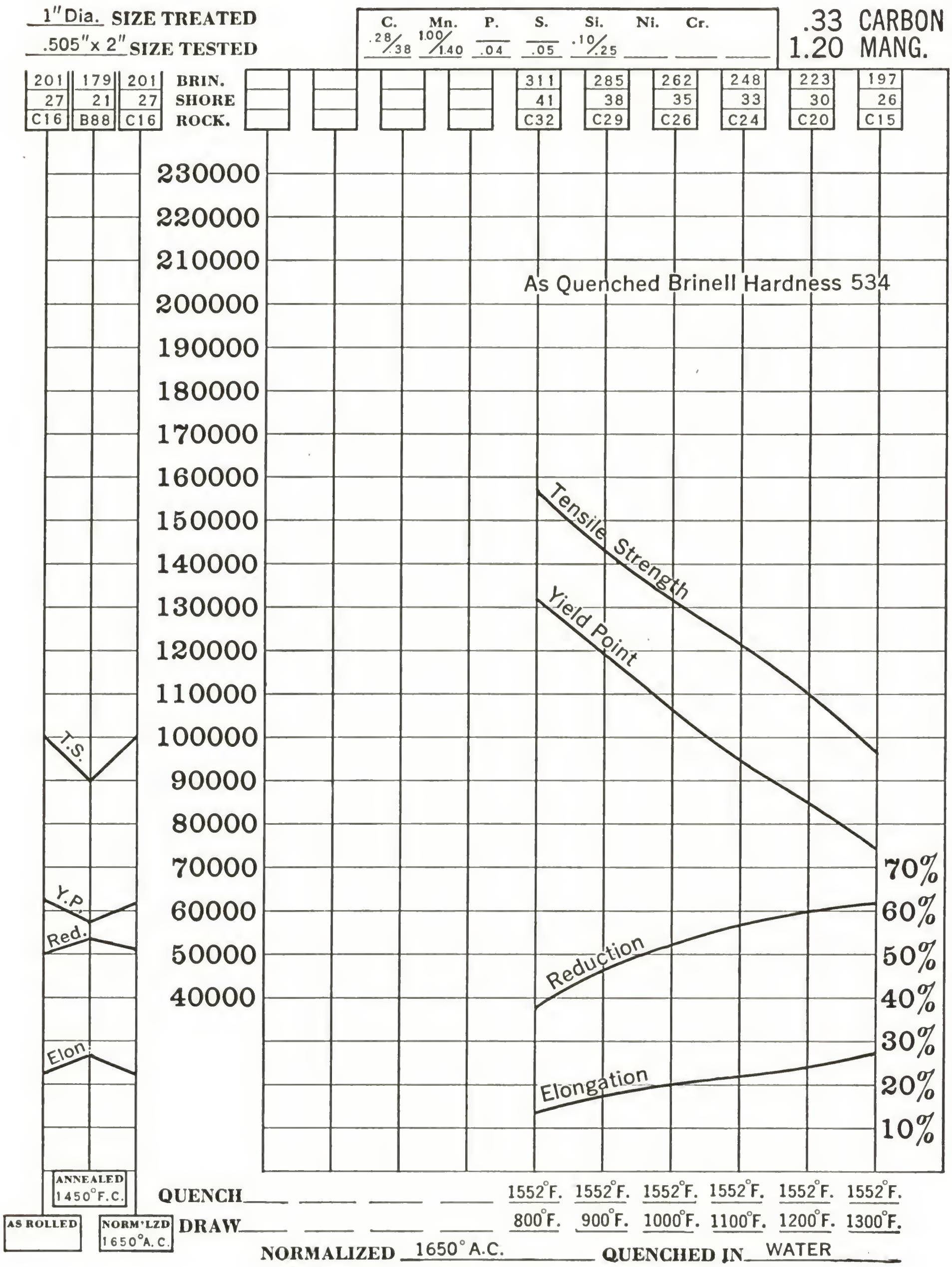
(Average Values)



PHYSICAL PROPERTIES CHART

.33 CARBON, 1.20 MANGANESE STEEL

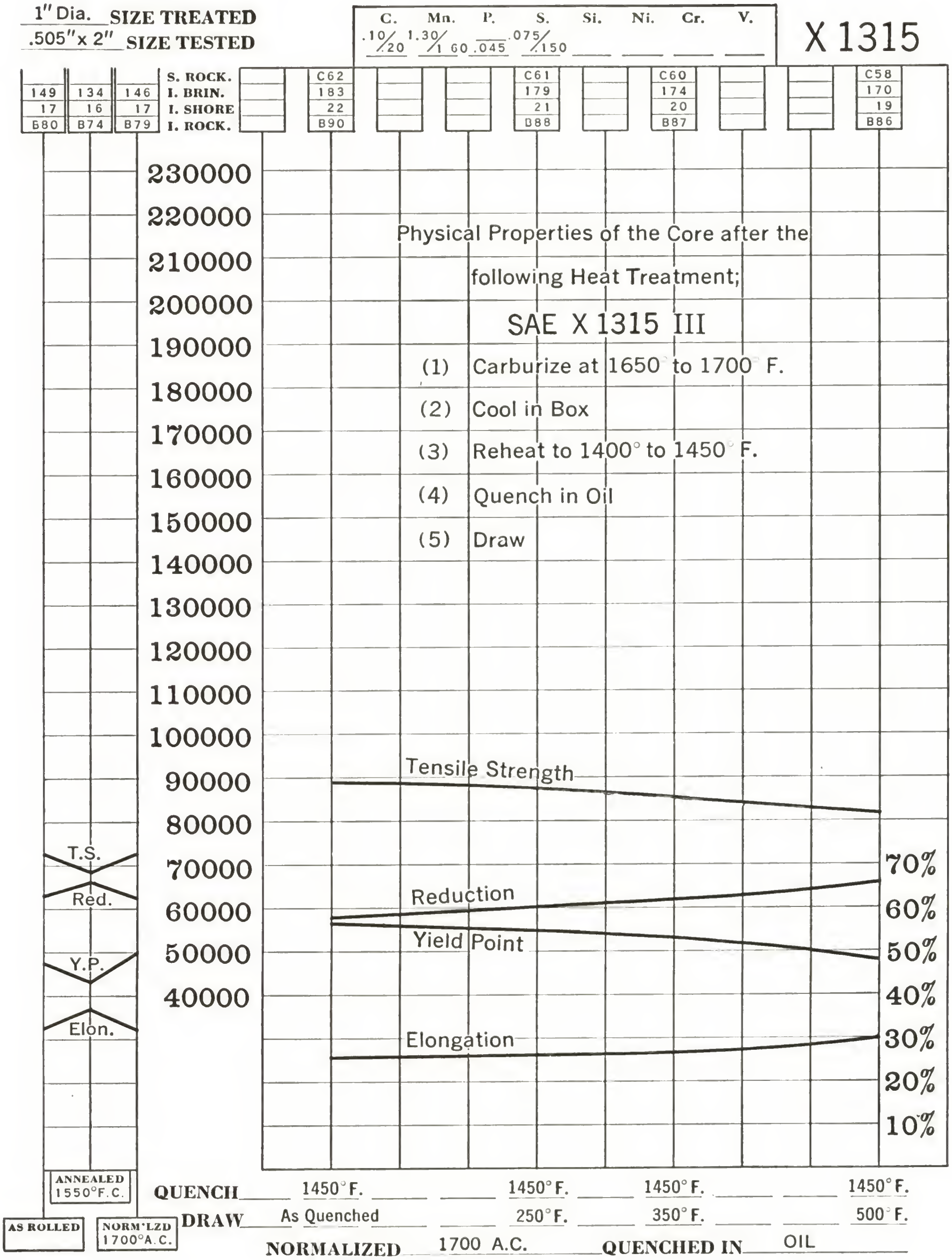
(Average Values)



PHYSICAL PROPERTIES CHART

S. A. E. X 1315

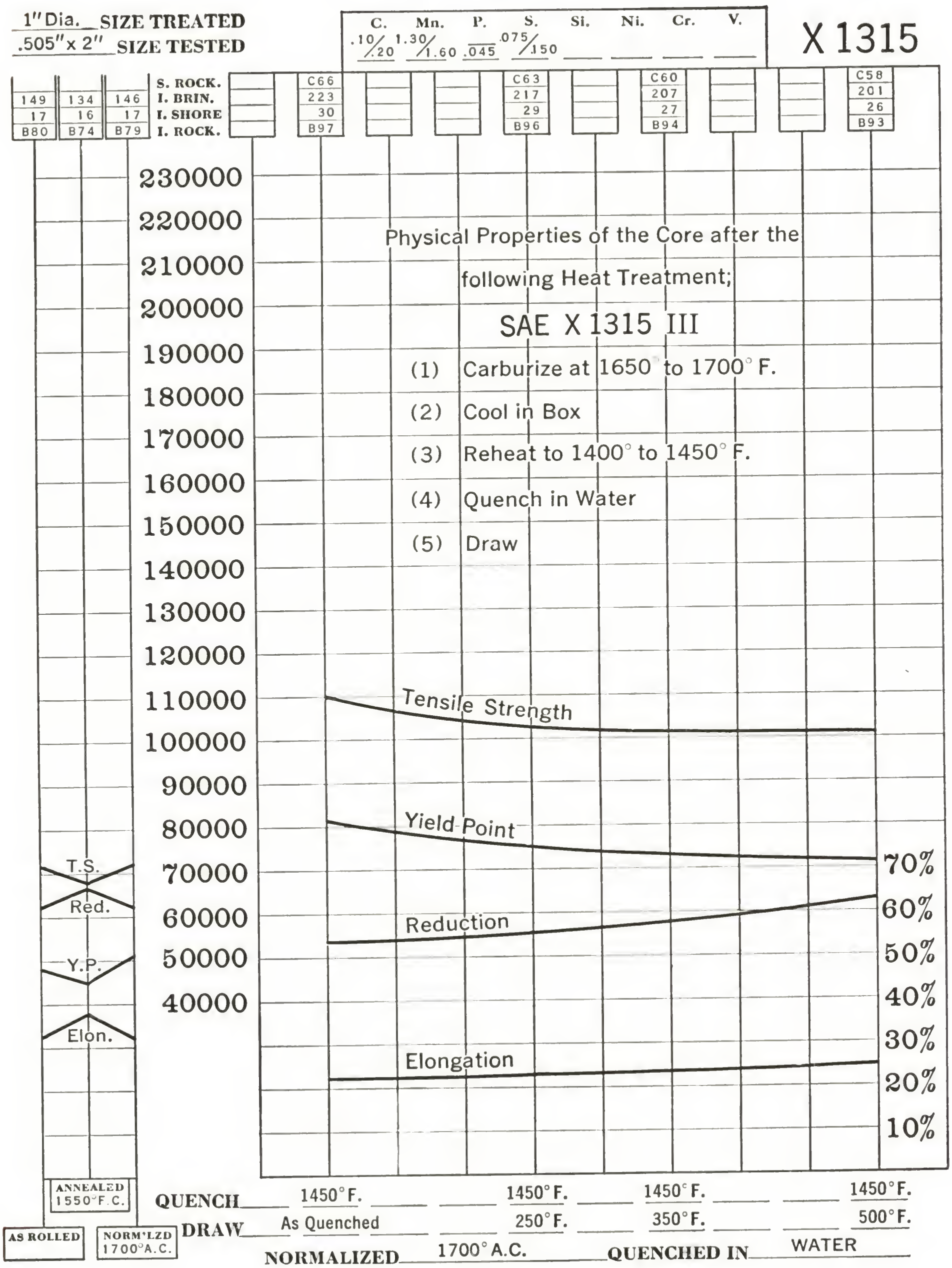
(Average Values)



PHYSICAL PROPERTIES CHART

S. A. E. X 1315

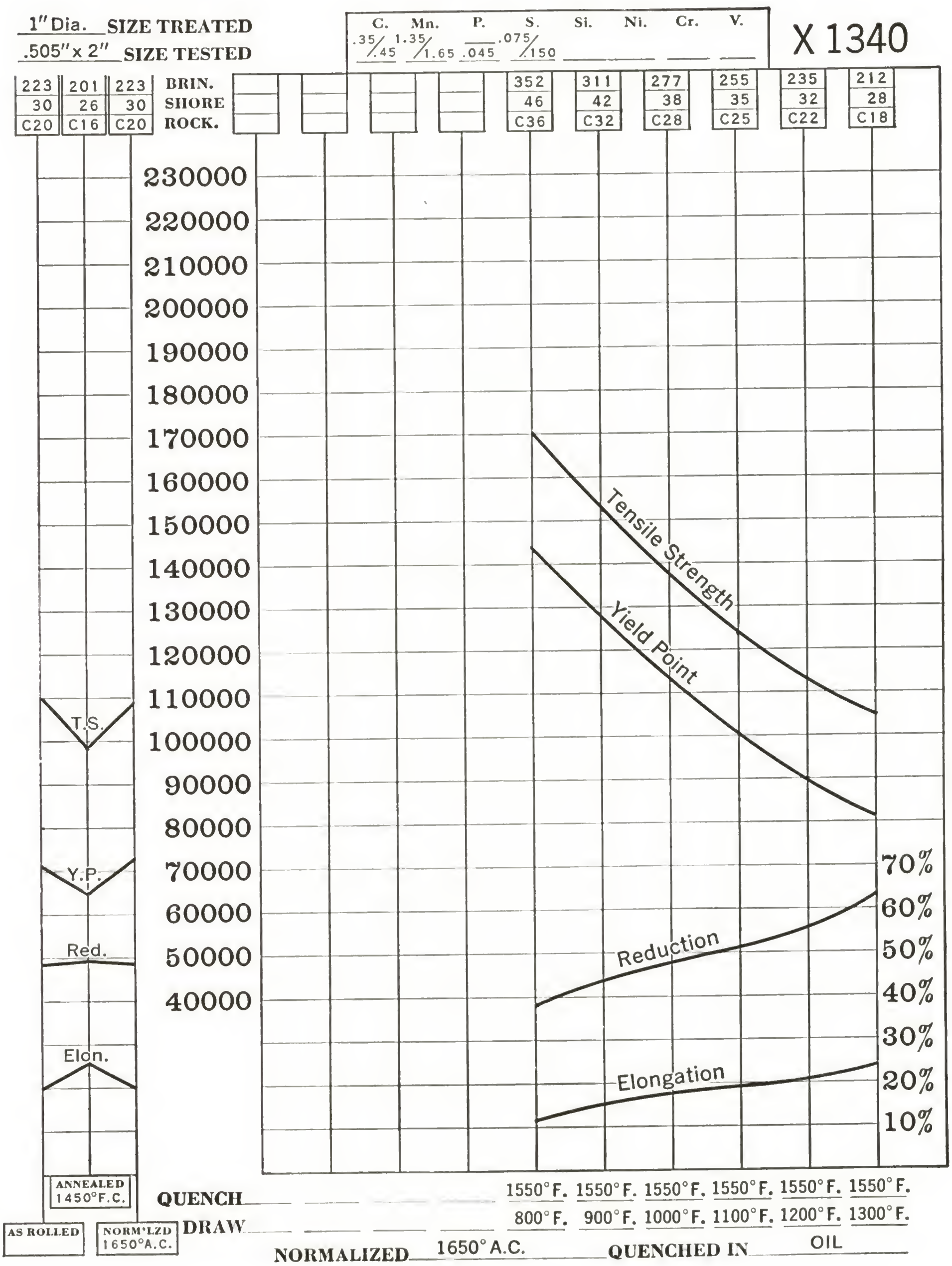
(Average Values)



PHYSICAL PROPERTIES CHART

S. A. E. X 1340

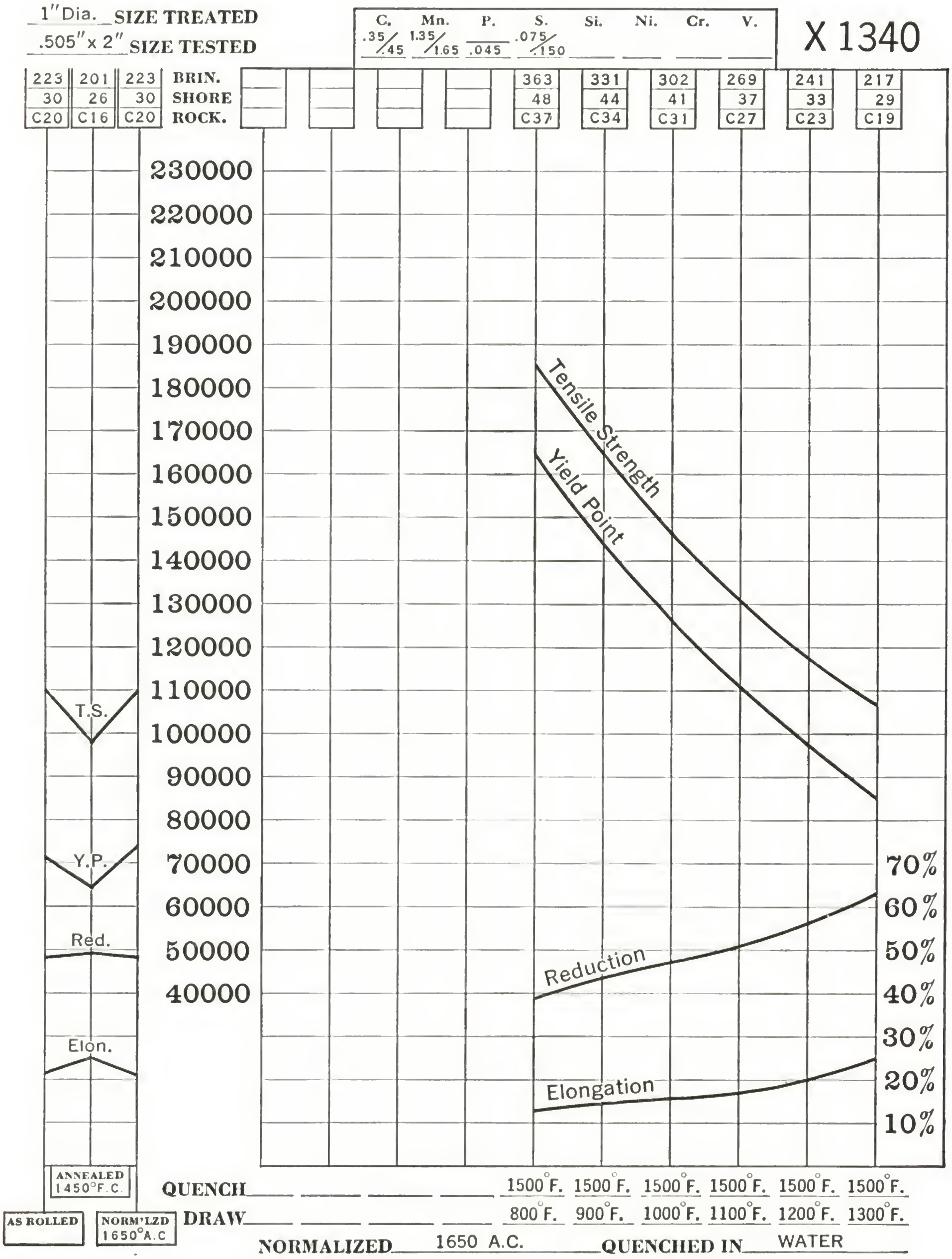
(Average Values)



PHYSICAL PROPERTIES CHART

S. A. E. X 1340

(Average Values)



STEELS FOR SPECIFIC USES

CARBURIZING STEELS

SUPER-MACHINING STEELS

STEELS FOR COLD DRAWING

AUTOMOTIVE STEELS

SPRING AND BUMPER STEELS

TOOL AND IMPLEMENT STEELS

BOLT, NUT AND RIVET STEELS

STEELS FOR JUVENILE VEHICLES

STEELS FOR RAILROAD SERVICE

TUBE ROUNDS

FORGINGS

CARBURIZING STEELS

A CARBURIZING steel is a low-carbon steel, which in service must, after carburizing and proper treatment, possess a tough shock-resisting core and a hard case to resist wear.

To obtain these results, the user has a choice not only of a number of different grades of steel but also of carburizing operations. In each case the service requirements must be balanced against the cost and treatment of the steel.

For light parts or where extremely tough cores are required, the carbon content should preferably be 0.18 per cent maximum. For heavy parts with strong cores carbon content should be from 0.15 to 0.25 per cent.

When the double quenching method is used, the first temperature is higher to refine the core and to dissolve the free carbides in the case, and the second temperature is lower to refine the high-carbon case and at the same time to temper the low-carbon core.

When one quench is used, it must be at the higher temperature if refinement of the core is the purpose of the treatment, as shown in the recommended heat treatment tables. A fine-grained (A.S.T.M. E19-33*) steel will be most satisfactory for this purpose, giving a minimum coarsening of the case.

Carburizing materials are either solids, liquids, or gases; the solid materials being most generally used. The rate of carbon penetration depends on the carburizing agent used, the length of time, and the degree of temperature to which the part is exposed during the carburizing operation.

Service requirements determine the final depth of the hardened case. For most parts the carbon penetration must be sufficiently deep to allow for the removal of 0.010 to 0.015 inch of material by subsequent grinding. If the part is of such a shape that unusual warpage is likely to occur, this allowance must be increased.

The case must be sufficiently deep to provide uniform hardening without soft spots and to withstand the required amount of wear in service. Unnecessarily deep cases increase cost and susceptibility to breakage by severe shock.

*See pages 205-214

S. A. E. RECOMMENDED HEAT TREATMENT (Revised 1935)

S.A.E. No.	Treat. No.	Normalize	Carburize Deg. F.	Cool	Reheat Deg. F.	Cool	Reheat Deg. F.	Cool	Draw Deg. F.
1010, 1015	I	......	1650–1700	quench	....	....	....	....	250–325
	II	......	1650–1700	quench	1400–1450	H_2O	....	....	250–325
	III	......	1650–1700	in box	1400–1450	H_2O	....	....	250–325
	IV	......	1650–1700	in box	1650–1700	oil or H_2O	1400–1450	H_2O	250–325
	V	......	1500–1650*	oil or H_2O	....	....	....	....	optional
X1015, 1020, X1020	I	......	1650–1700	quench	....	....	....	....	250–325
	II	......	1650–1700	quench	1400–1450	oil or H_2O	....	....	250–325
	III	......	1650–1700	in box	1400–1450	oil or H_2O	....	....	250–325
	IV	......	1650–1700	in box	1650–1700	oil or H_2O	1400–1450	quench	250–325
	V	......	1500–1650*	oil or H_2O	....	....	....	....	optional
1025, X1025, 1030	III	......	1500–1650*	oil or H_2O	....	....	....	....	optional
1112	I	......	1500–1650*	oil or H_2O	....	....	....	....	optional
1115, 1120, X1314, X1315	I	......	1650–1700	quench	....	....	....	....	250–325
	II	......	1650–1700	quench	1400–1450	quench	....	....	250–325
	III	......	1650–1700	in box	1400–1450	quench	....	....	250–325
	IV	......	1650–1700	in box	1650–1700	quench	1400–1450	quench	250–325
	V	......	1500–1650*	oil or H_2O	....	....	....	....	optional

* = In Cyanide or activated baths.

Physical laboratory at the Lackawanna plant

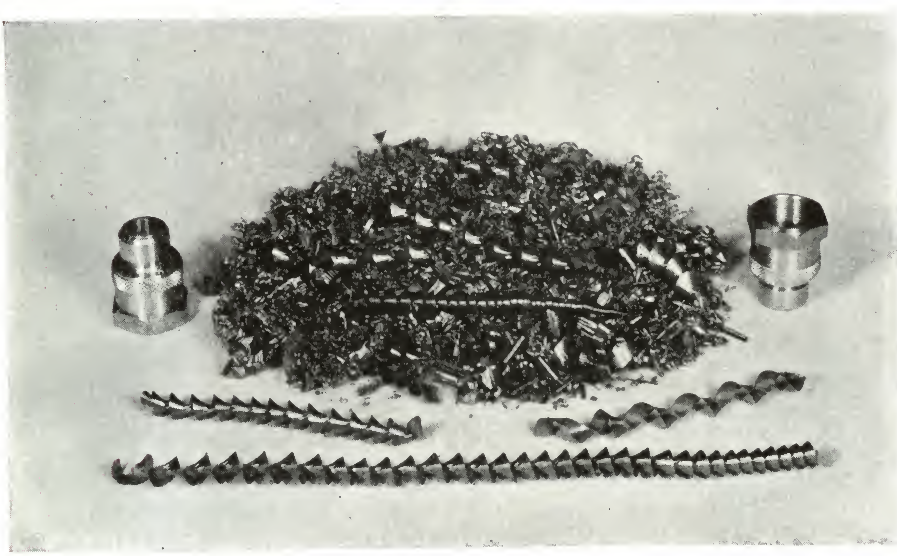
SUPER-MACHINING STEELS

THE demands of industry for fast, economical machining of parts have led to the rapid development of tools, machines and free-cutting steels.

The steel maker regulates such contributing factors as composition, rolling temperature, and structure of the steel, to impart maximum machining properties to meet exacting requirements.

Chemical composition plays a very important part in producing free-machining steels. The free-cutting steels are usually of a low carbon grade. In order to secure free-machining qualities in this grade the judicious use of manganese, phosphorus and sulphur is necessary, otherwise the steel would be soft and gummy, yielding chips which would not curl satisfactorily, thereby preventing the cutting compound from reaching the edge of the tool.

Manganese imparts strength to the steel and adds to its machinability. Phosphorus is also a hardener and aids machinability. However, the most important element for imparting free-machining properties is sulphur, and steels are now being furnished with sulphur ranges of 0.075 to 0.15 per cent, 0.10 to 0.20 per cent and 0.20 to 0.30 per cent.



An example of fair machinability

Free-machining steels are produced by both the bessemer and open hearth processes. Unless phosphorus is deliberately added, bessemer steels usually contain from 0.09 to 0.13 per cent, and open hearth steels less than 0.045 per cent.

Rolling temperatures, when properly regulated, contribute additional free-machining qualities.

In general, the "coarse-grained" steels (A.S.T.M. E19-33) prove best in respect to free-machining qualities.

Super-machining steels can be machined at unusually high cutting speeds and they produce a smooth, bright, clean finish.

Much of the present-day high speed cutting is done on automatic machines. This requires bar stock with both free-machining properties and close tolerances in section and straightness. As a consequence, a large percentage of steel for this purpose is cold drawn.

Cold drawing produces sizes to closer tolerances and through the mechanical cold working improves machinability by increasing the hardness of the stock and beneficially deforming the grain structure. It also provides a steel free from scale, thereby increasing the life of the tool. For further comments see pages 186, 215 and 216.

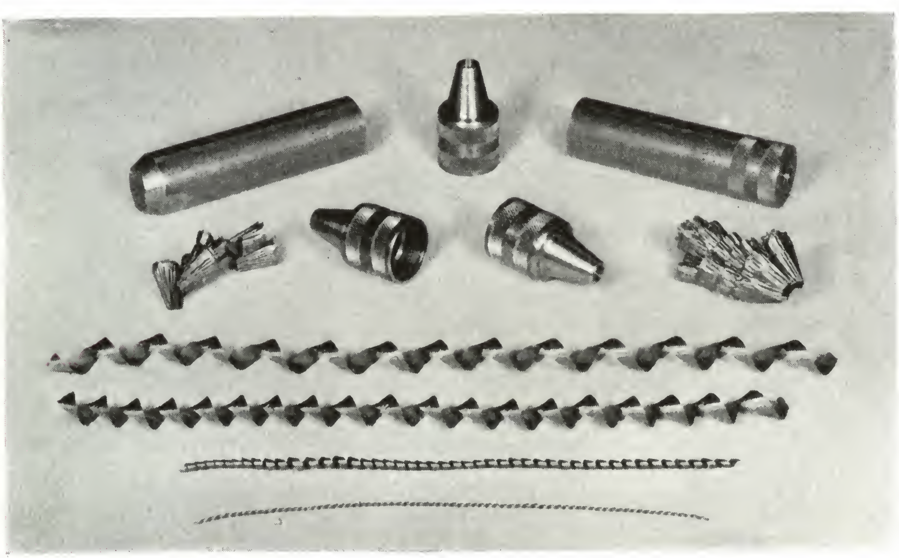
An example of good machinability

Questions about machinability are extremely hard to answer since often the same steel for similar parts will behave differently in two shops due to variations in operating conditions.

There are two distinct sides to questions about machinability — one which concerns the material to be machined and the other which concerns the machining operation. In each of these are a large number of variables, all of which are factors contributing to the performance of the steel.

From the standpoint of material to be machined, the variables already referred to include composition, hardness and mechanical work. Rolling or finishing temperatures and grain size (A.S.T.M. E19-33) have likewise been mentioned. The method of making the steel and the subsequent processing have their influence. If the steel is heat treated, the resultant grain structure has a bearing on the subject.

From the standpoint of the machining operations there are likewise many variables to complicate the problem. Among these we might mention feeds; speeds; capacity of the machine used; design of the part being produced; operation, whether broaching, drilling, turning, boring, etc.; cutting compound; tool rake, tool cutting angle, tool size, etc.; steadiness of tool; and so forth.



An example of poor machinability

In 1900 Taylor and White presented a valuable treatise on machining in conjunction with the development of high speed cutting tools. Most of the work carried out to develop these data was done at the plant of the Bethlehem Iron Works, which later became the Bethlehem Steel Company.

Since that time individuals and industrial, educational and technical institutions have contributed much additional information on this subject. In every case, however, the problem is so involved that no definite conclusions can be drawn except those which affect only one, or possibly two, of the many variables, with the other factors maintained approximately constant.

While admittedly the study of the type of chip produced in machining operations is by no means an infallible method of diagnosing machinability, some valuable information can be derived from the study, especially by an experienced man. Observations of the shape, length, brittleness, springiness, color, etc., of the chips are only worth while when comparing steels under similar machining conditions.

An example of good machinability

STEELS FOR COLD DRAWING

THIS subject has been referred to in super-machining steels. However, many other grades of steel are cold drawn to secure the benefit of accuracy of size and improvement of finish.

Every grade of carbon steel referred to in this book may be cold drawn. In the case of the harder steels it may be necessary to anneal prior to drawing. Carbon steels with carbon content over 0.50 per cent, or with carbon above 0.40 per cent and manganese over 1.00 per cent are usually annealed before mechanical cold working operations.

Bars to be cold drawn must be of excellent quality. The steel must be sound and free from excessive segregations, or internal ruptures will result. The surface must be free from seams, slivers and other imperfections, as no metal is actually removed and any surface defects, even though hidden under the scale or rust of the "as-rolled" bar, will show prominently on the cold drawn bar.

The structure of steel is changed in the process of cold drawing, as is revealed when it is examined under a high-power microscope. The mechanical work distorts or elongates the grains and this condition is therefore reflected in changed physical properties. This change is discussed in "Effect of Cold Drawing on Tensile Properties of Steel" on pages 215 and 216.

Bethlehem does not produce cold drawn carbon steel bars but does furnish a very large tonnage of bars to the cold drawing steel industry. Both bessemer and open hearth steels are available in all sizes and shapes generally used for cold drawing.

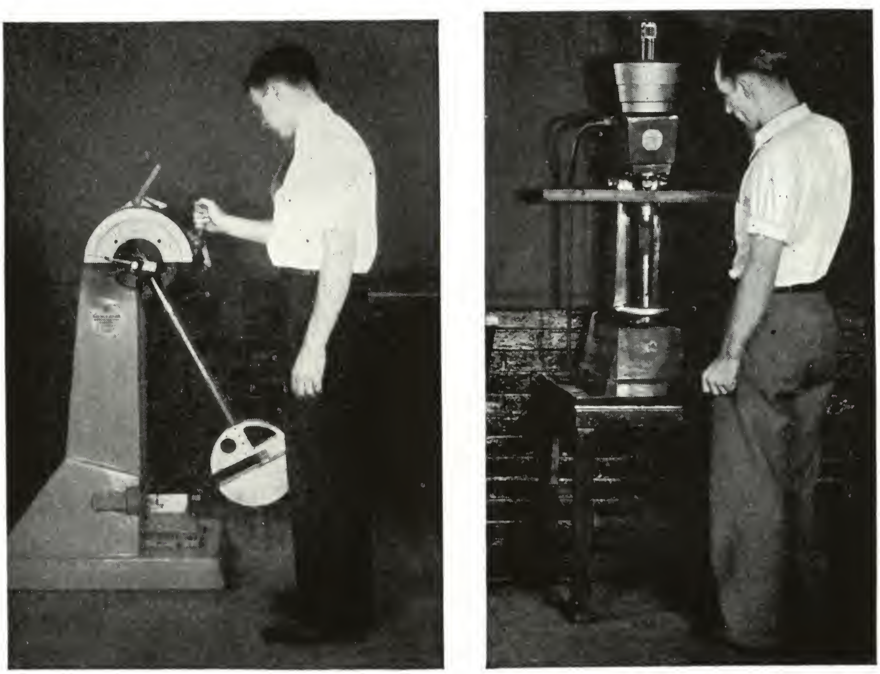
Bar in "as rolled" condition

Cold drawn bar

AUTOMOTIVE STEELS

THE automotive industry is a large consumer of quality carbon steel. This use has increased, through the regulation of the characteristics of the steel in addition to control of the chemical composition. Carburizing, oil and water-hardening grades are being used on many important parts of both passenger cars and trucks.

There are wide variations in the use of carbon steel in making definite parts, due to differences in design and consequent loads imposed. It is impossible to give a comprehensive list of these parts, however, carbon steels are meeting requirements for such parts as crankshafts, springs, bumpers, cams, levers, gears, connecting rods, front axles, brackets, transmission parts, brake drums, brake shoe tees, cam shafts, rear axle housings, spring plate seats, drive shafts, hubs, generator frames, pole shoes, spark plug shells, rim sections, side ring sections, steering arm supports, tie rods, and many other important parts.



Impact and hardness testing at the Cambria plant

SPRING AND BUMPER STEELS

BETHLEHEM carbon spring steel has proved, over years of service, to be entirely satisfactory in both elliptical and helical springs for service in automobiles, trucks, locomotives, railway and street cars, light vehicles and machine parts. The composition and characteristics are so regulated that satisfactory response to heat treatment is assured. The finishing temperature of this steel is controlled and the hot rolled bars are pack annealed while cooling, to obtain the best shearing and punching properties in a steel of this natural hardness. Accuracy of size, straightness and good surface are important factors.

The utility of a spring is measured by its resilience and endurance under given loads, and the limitations lie in both the material and design. A spring subjected to sudden bend or torque must possess a good combination of strength, elasticity and ductility.

Steel which has been fabricated into springs is usually, after quenching, drawn to a Brinell hardness of from 388 to 444 (3.1 to 2.9 mm. diam).

The function of a spring is to dissipate energy mainly through internal strain friction within the elastic limit of the material. If the stresses are light, the life of the spring will be long. If the stresses are heavy and of high frequency, even though within the elastic limit of the steel, the duration of life is shortened.

It is a peculiarity of metal that, given time, it will recover after applications of stresses within the elastic limit. The so-called "fatigue" develops when there is insufficient time for recovery. Proper methods of manufacture and effective heat treatment can minimize this effect and aid in prolonging the life of a spring.

In the hardening of springs, uniformity in results depends on the effectiveness of the quenching operation and the size of the section treated. Effort is made to eliminate one of the heat treatment variables by giving careful consideration to the hardening elements of the steel used for different sizes, so that as far as possible, with the same treatment under the same conditions, the hardness of the different spring steel sections in the heat-treated condition will for all practical purposes be the same.

Bethlehem produces a number of different grades of carbon spring steel but all are based, with slight variations, on the S. A. E. 1095 type with the proper hardening characteristics.

Bumper steel is produced in a large variety of sections. In addition to possessing the usual properties of spring steel, the product must be finished at the mill with a surface which requires the minimum grinding and polishing for plating. This requires mills which are adequately provided with facilities for removing the scale as the billet is being rolled into final shape, and on which the speed can be regulated so that the bumper section is finished at the proper temperature.

Preparing specimens for metallographic examination

TOOL AND IMPLEMENT STEELS

CARBON steels are furnished to the tool maker for such parts as hammers, chisels, files, wrenches, wrench teeth, pliers, screw-driver blades, tool holders, sockets, arbors, wedges, etc.

For agricultural implements, carbon steels are used for hoes, forks, rakes, plow shares, seats, drill points, harrow teeth, spades, shovels, shears, cultivator discs, etc.

The machine builder uses carbon steel for many parts such as carburized or heat-treated gears and pinions, tool holders, shafts, feed screws, splines, connecting rods, heads, racks, pins, keys, etc.

Other uses for which carbon steels are furnished, are wear resistant blades for road scrapers, beater bars, scissors, hatchets, axes, machetes, bits, axe pole steel, nut locks, etc.

It would be rather futile to list the recommended compositions and types of steel for these various uses. In many cases the user has a choice of steels, and the recommendation may be one of a number of steels, the selection depending upon which is best suited to the further processing equipment available and the service requirements.

Machining specimens for testing and examination

BOLT, NUT AND RIVET STEELS

A LARGE number of different chemical analyses are specified for all these commodities, depending not only on the strength or hardness desired in the finished product, but also on the method of processing, whether hot or cold, etc. Open hearth steel is generally used.

Stock for these parts is furnished both in straight lengths or coils, as desired.

In producing bolts and nuts, one of the desired qualities of the steel is good machinability. Where permissible therefore, the higher sulphur steels may be used; the general exception to this being steel for cold formed bolts. Some bolts and nuts are heat treated and in this case the sulphur is normal with sufficient carbon and manganese to insure the desired response to treatment.

Steel for bolts and rivets must have both a good surface and uniform interior in order to prevent splitting of the heads, and, in the case of bolts, to insure strong threads. Copper-bearing steel is sometimes specified to provide increased resistance to atmospheric corrosion.

Nuts are usually made by punching direct from a flat bar. For satisfactory nut flats special mill practice must be followed. Other methods of processing nuts are used which require hexagonals or other sections, and in some cases cold drawn stock is used to obtain close tolerances over the outer dimensions of the nuts.

STEELS FOR JUVENILE VEHICLES

A LARGE tonnage of carbon steel bar stock is used in the manufacture of bicycles, baby carriages, sleds, etc. It is relatively as important to have safe parts made from the proper steel for these light vehicles as it is to have safe parts for automobiles or railway cars.

Where helical springs are used, they are generally hot formed from standard carbon spring steel and heat treated. Where the loads are very light, softer steel, either bessemer or open hearth,

may be specified and in this case the springs are usually cold formed and not heat treated. Elliptical springs bearing light loads are made mostly from bessemer steel because of its natural stiffness.

Sled runners are generally made from special section tees of such analysis that they can be punched satisfactorily and at the same time have sufficient strength and hardness for use without heat treatment.

STEELS FOR RAILROAD SERVICE

BY FAR the largest percentage of bars and special sections used by the railroads consists of carbon steels. Their uses are so wide and varied that the railroads have requirements for all grades and types. The steel, whether in track equipment, maintenance parts, prime movers or rolling stock, must be reliable under all of the many service conditions.

The majority of parts for railroad equipment are made from steel in the "as-rolled" or "as-forged" condition; but when subjected to heavy loads, such parts as axles, crank pins, side rods, etc., usually require heat treatment. For most parts this treatment consists of normalizing and annealing, but for others, depending on the size and the service and properties desired, liquid quenching and drawing are employed.

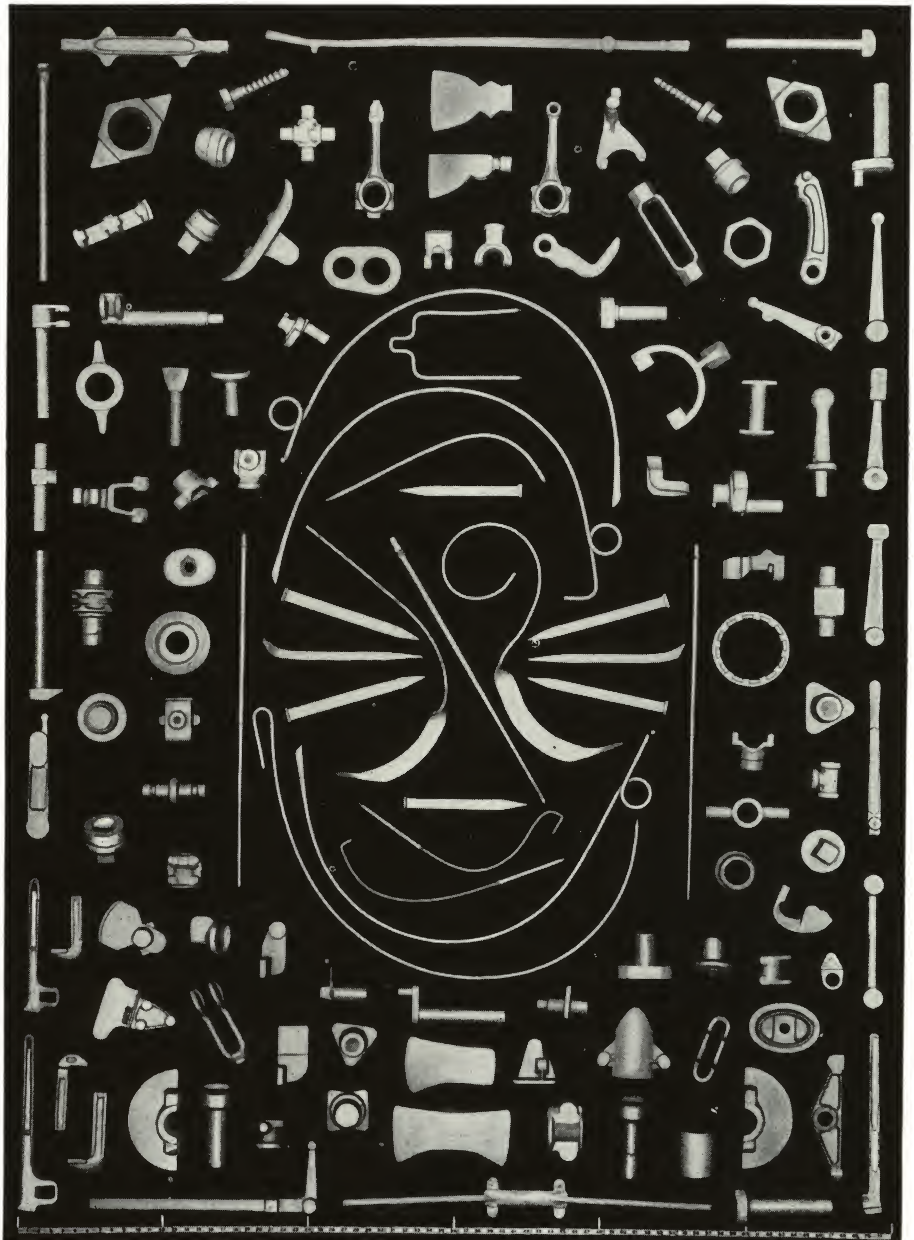
TUBE ROUNDS

THE LACKAWANNA plant was among the pioneers in the development of rounds for the manufacture of seamless tubing by hot piercing. Tube rounds are now regularly produced at the Bethlehem bar mills.

The steel is furnished to the analysis required to produce the physical properties desired in the tubing. In the low carbon grade, either rimmed or killed steel can be furnished at the option of the tube maker.

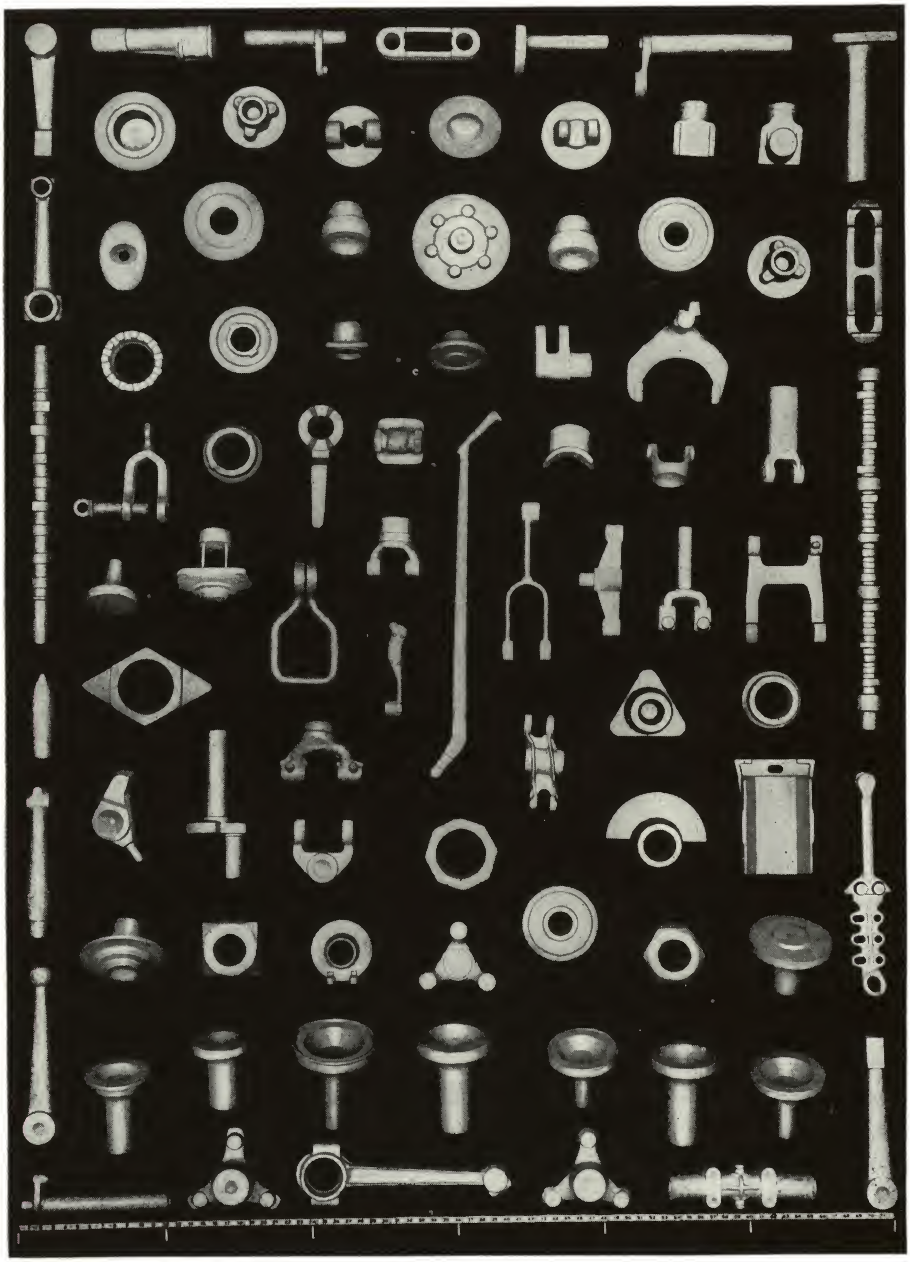
In the final product, both the exterior and interior surfaces are carefully inspected and therefore the rounds must have both a good surface and sound interior.

TYPICAL CARBON STEEL FORGINGS



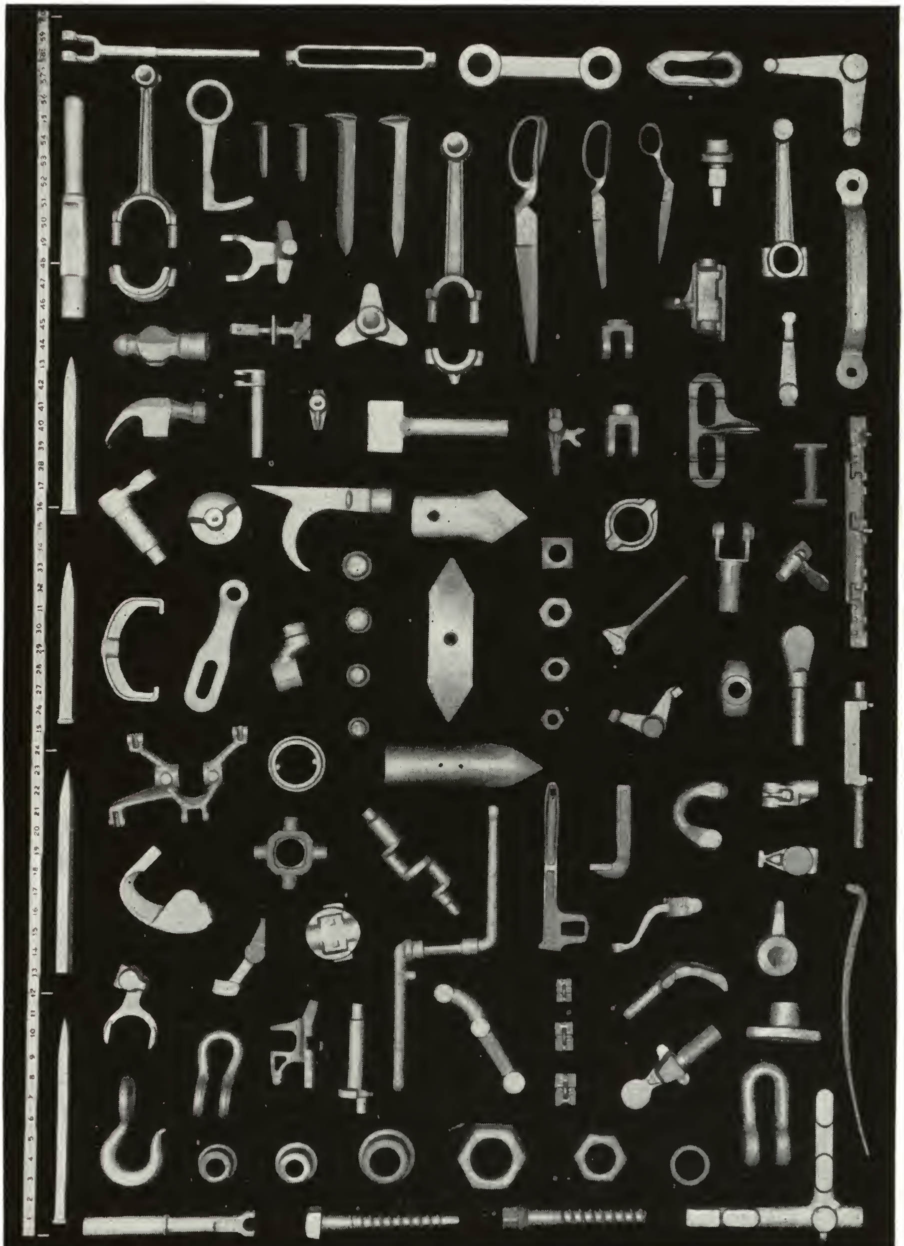
Above photograph obtained through the courtesy of many of our customers who use Bethlehem Carbon Steels for the making of forgings.

TYPICAL CARBON STEEL FORGINGS



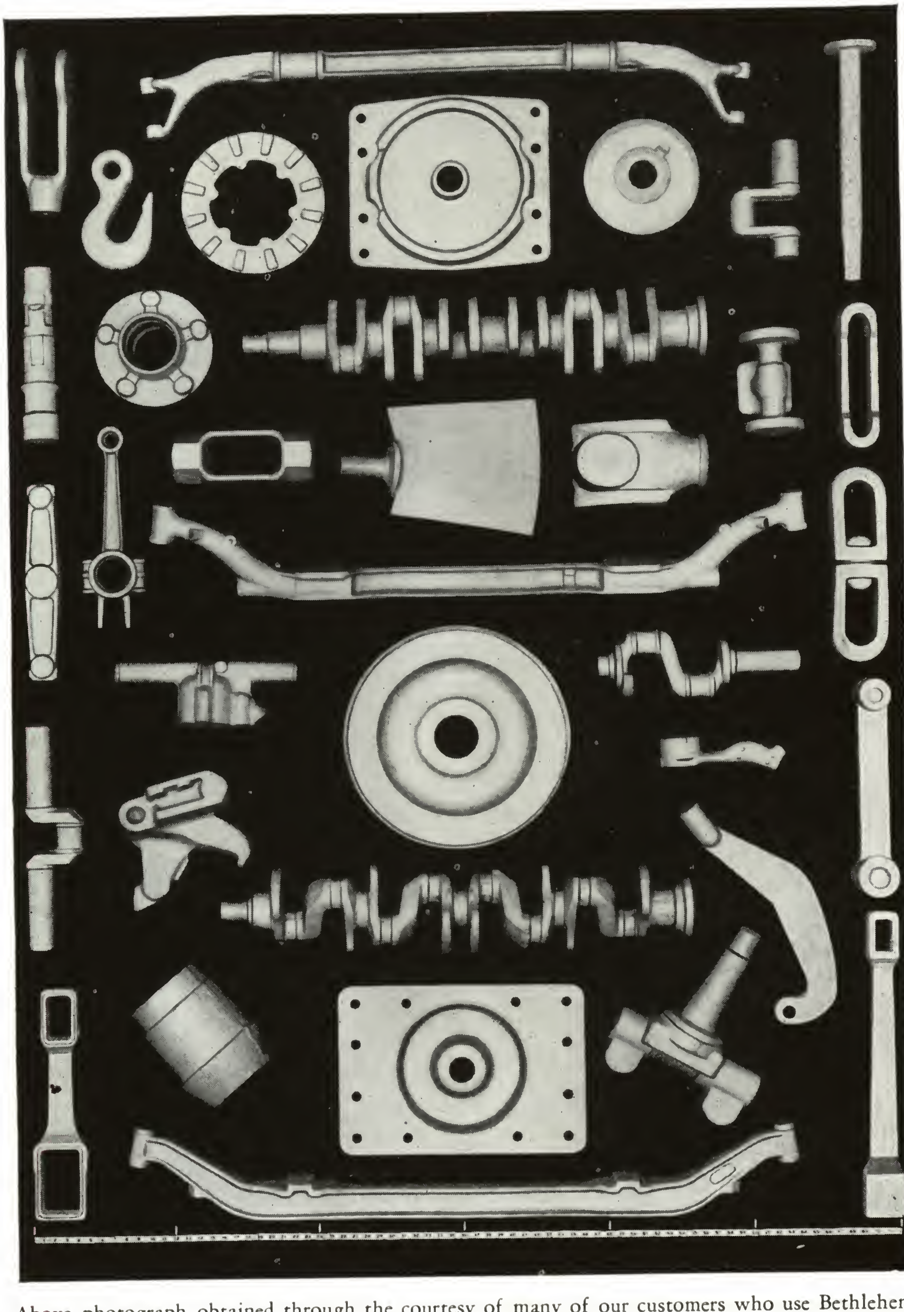
Above photograph obtained through the courtesy of many of our customers who use Bethlehem Carbon Steels for the making of forgings.

TYPICAL CARBON STEEL FORGINGS



Above photograph obtained through the courtesy of many of our customers who use Bethlehem Carbon Steels for the making of forgings.

TYPICAL CARBON STEEL FORGINGS



Above photograph obtained through the courtesy of many of our customers who use Bethlehem Carbon Steels for the making of forgings.

TESTING AND PROPERTIES OF STEELS

HARDENING CHARACTERISTICS OF STEEL
A. S. T. M. SPEC. E19-33

EFFECT OF COLD DRAWING ON TENSILE PROPERTIES OF CARBON STEEL

EFFECT OF SIZE OF TEST BAR

EFFECT OF MASS ON PROPERTIES OF HEAT-TREATED STEEL

ENDURANCE STRENGTH OF STEEL

DEFLECTION OF STEEL UNDER STRESS

IRON-CARBON DIAGRAM

CHEMISTRY

COMPOSITION HARDNESS

HOT ACID ETCHING

TENSION TEST TERMS

HARDENING CHARACTERISTICS OF STEEL

THE best known and most widely used method for determining the hardening characteristics of open hearth carbon steel is the A.S.T.M. E19-33[1] test, a copy of which is given on pages 205 to 214 inclusive. Other useful and valuable tests have been developed but they are not as well known, or are applied to steel for specific purposes or uses.

Bethlehem Steel Company was among the pioneers in using the A.S.T.M. E19-33 test to classify steels which are subsequently to be heat treated. This problem has been studied since 1922, and, where practical, use of this knowledge has been made to the production of steel for better performance.

A number of investigators have been studying this method of classification together with the performance of the steel in processing and service and as a result many variations and changes have been brought forth since the test was originally proposed. Much progress has been made up to the present time, but considerable further knowledge is necessary both from the research and performance viewpoint before a final method of practical application is set up.

During the early investigations leading to the A.S.T.M. E19-33 test, the terms "normal" and "abnormal" were used to describe the condition of the grain boundaries. These rather unsatisfactory terms led to considerable confusion, since the condition described as "abnormal" does not necessarily refer to steel of inferior or questionable quality. These terms are not used now as often as formerly, since more attention is paid to grain size.

This test is used principally to classify steels in accordance with their response to one definite heat treatment. Steels are classified according to grain size after being carburized at one established temperature for a definite length of time. For classifying, the grain size of the case is always used, although some tests also include a record of the grain size of the core, or the transition zone.

1 Note: Original papers were presented by H. W. McQuaid and E. W. Ehn, Trans. American Inst. Mining and Metallurgical Eng. Vol. LXVII; 1922 Trans. American Society for Steel Treating, Sept. 1922; Journal American Iron and Steel Inst. V 105, May 1922.

It must not be assumed that the results obtained from the definitely prescribed treatment are indicative of the results that would be obtained if the temperature were raised or lowered. In most instances this will have a direct bearing on the grain size developed; that is, higher temperatures may coarsen the grain and lower temperatures may produce a finer grain. On page 200 are shown different steels carburized over a range of temperatures, and a comparison of the same steels normalized over the same range of temperatures is shown on page 201. The close parallel between the two types of heat treatment is readily seen.

By grain size regulation or control is meant the production of either "coarse-grained steels" or "fine-grained steels" for specific purposes. These two classifications are set forth in the A.S.T.M. E19-33 test. The influence of "normality" on the properties of coarse and fine-grained steels has not definitely been proved, although there is strong indication that "normal" steels show greater hardness in the as-quenched condition than "abnormal".

"Coarse-grained steels" have, in general, been found to possess inherently deeper hardening properties and to respond better than "fine-grained steels" when subjected to liquid quenching. They are also usually found to have better machining properties, especially when the cuts are fine or light.

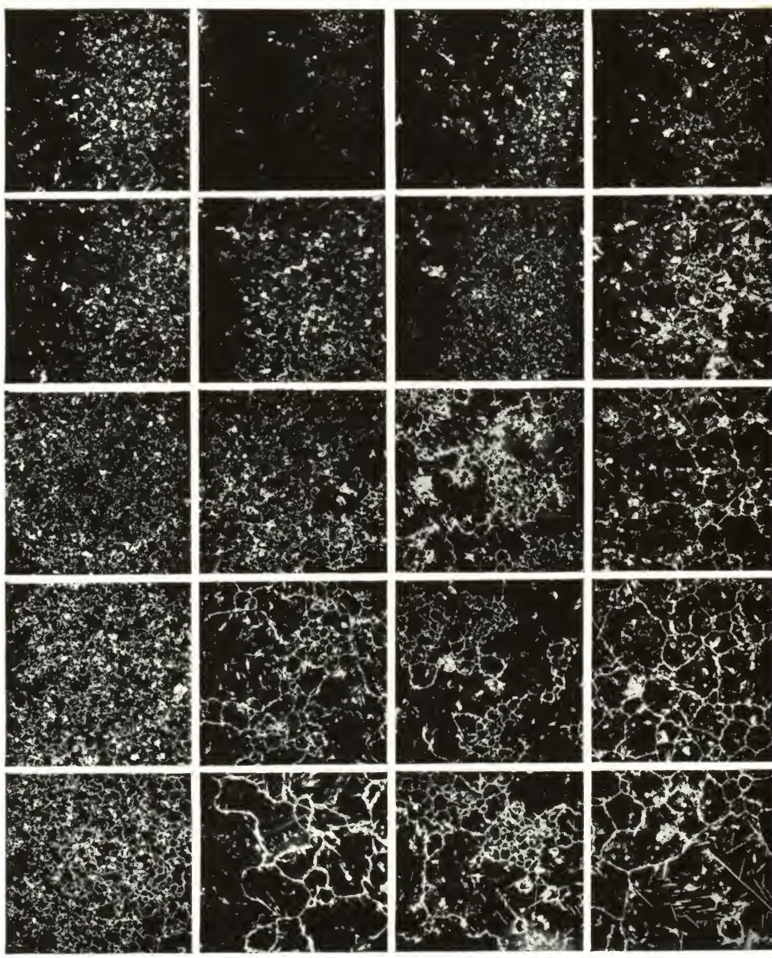
"Fine-grained steels" as compared with "coarse-grained steels" are, in general, found to have a better surface condition; greater impact strength and toughness; less distortion in treatment; less tendency to crack in trimming after forging, or during treatment or grinding; and to be safer when heat-treating intricate or sharply filleted parts. In the carburizing grades they may be single quenched, producing the finer grained case and core, as shown by fracture. Double quenching naturally increases the refinement of the structure.

The P-F[2] Test is used mainly in connection with carbon tool steel. This test was developed to evaluate heats of steel of similar chemical analysis but in which there is an inherent difference in hardness penetration, fracture grain size, quenching sensitivity, tendency toward grinding checks, toughness, fatigue resistance, etc.

2 Note: "The P-F Characteristic of Steel" by B. F. Shepherd, Trans. American Society for Metals, 1934, V 22.

EFFECT OF TEMPERATURE ON GRAIN SIZE OF CARBURIZED STEEL

CARBURIZED GRAIN SIZE
A. S. T. M. E19-33 rating



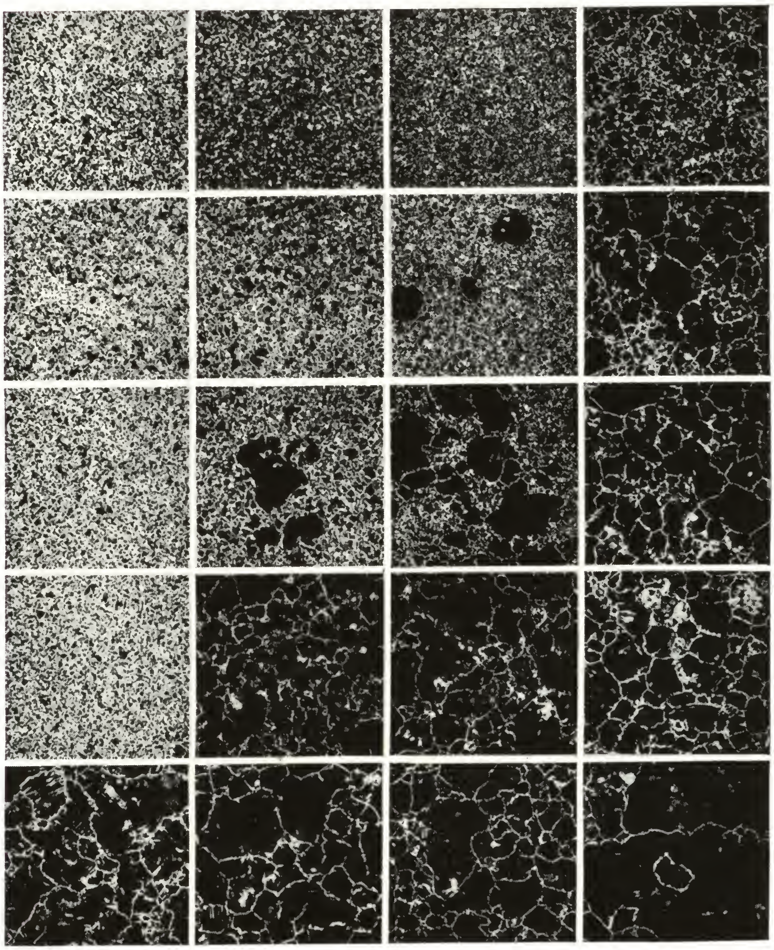
*Carburizing temperature of A. S. T. M., E19-33 test.

EFFECT OF TEMPERATURE ON GRAIN SIZE OF NORMALIZED STEEL

NORMALIZED GRAIN SIZE
A. S. T. M. E19-33 rating

Fine Grain | Mixed Grain Fine tendency | Mixed Grain Coarse tendency | Coarse Grain

1550°F.
1625°F.
*1700°F.
1825°F.
1925°F.



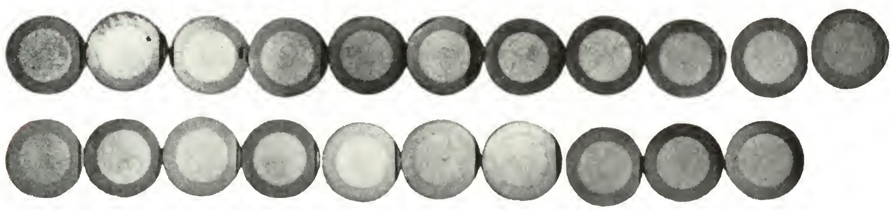
*Carburizing temperature of A. S. T. M., E19-33 test.

P-F TESTS ON AN OPEN HEARTH HEAT OF STEEL

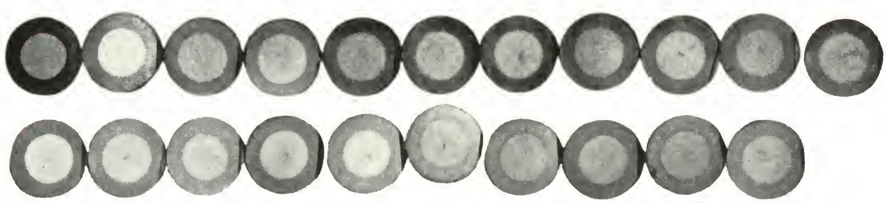
Each specimen is from a different ingot

PENETRATION

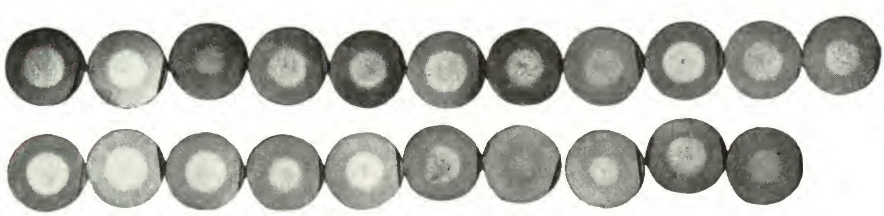
1450° F.



1500° F.



1550° F.



1600° F.

P-F TESTS ON AN OPEN HEARTH HEAT OF STEEL

Each specimen is from a different ingot

FRACTURE

1450° F.

1500° F.

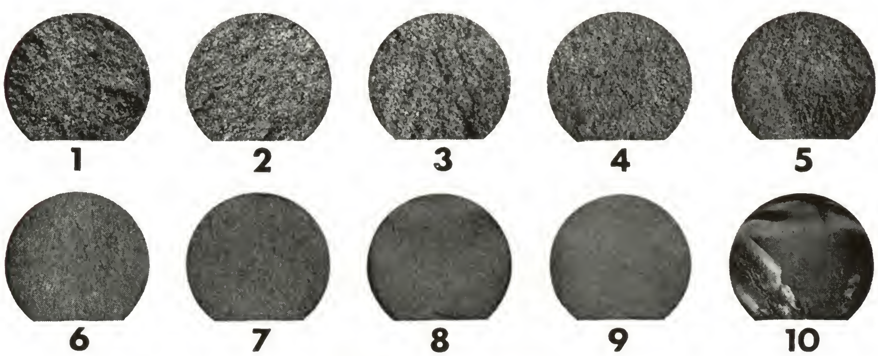
1550° F.

1600° F.

The P-F Test gives results which in general parallel or compare directly with the A.S.T.M. E19-33 carburizing test. The results can be directly applied to shop practice.

The P-F Test consists of determining differences in the penetration of hardness (P value) and in the fracture grain size (F value) of samples quenched from normal and from an arbitrary series of higher temperatures at predetermined intervals.

The grain size of the fracture is measured by visual comparison with an empirical set of standards made from fractures of martensitic steel. The hardness penetration is recorded as the numerator of the fraction which expresses in sixty-fourths of an inch the depth of the hardened zone on etched samples.



P-F fracture standards

Another test[3], developed recently, is a study of the grain size of quenched specimens. While, in a way, this test parallels the A.S.T.M. E19-33 test, it is somewhat more comprehensive and does not require a carburizing operation, and further, like the P-F Test, it covers the study of steel heat treated over a range of temperatures. It furnishes information which can be directly used in practice.

3 Note: "General Relations between Grain Size and Hardenability and the Normality of Steels" by E. S Davenport and E. C. Bain, Trans. American Society for Metals, 1934, V 22

AMERICAN SOCIETY FOR TESTING MATERIALS

STANDARD GRAIN SIZE CHART

FOR

CLASSIFICATION OF STEELS[1]

A. S. T. M. Designation: E19-33

This chart is issued under the fixed designation E19; the final number indicates the year of original adoption as standard or, in the case of revision, the year of last revision.

Adopted, 1933.

Scope

1. This chart is intended to be used primarily for classification of S.A.E. and allied structural steels according to grain size which concerns only the size of the pearlitic grains and is independent of the condition of the excess carbide.

Treatment of Specimen

2. It is recommended that grain size studies be made only on specimens having prepared surfaces which are free from oxidation, decarburization, and influence of cold work.

The specimen shall be carburized at 1700° F. (927° C.) for not less than eight hours in a compound which will produce a hyper-eutectoid zone. Any of the highly energized compounds on the market will be satisfactory for this purpose. The specimen must be cooled slowly enough to produce a pearlitic structure. This is usually accomplished by furnace cooling. After cooling, a micro-section shall be prepared and the carburized zone examined at 100 diameters magnification and then compared with the grain size chart shown on pages 207-214 inclusive.

Grain Size Classification

3. (*a*) Sizes Nos. 1 to 5 may be considered "coarse-grained" steels and are generally characterized by complete carbide envelopes in the hypereutectoid zone.

[1] Under the standardization procedure of the Society, this chart is under the jurisdiction of the A. S. T. M. Committee E-4 on Metallography.

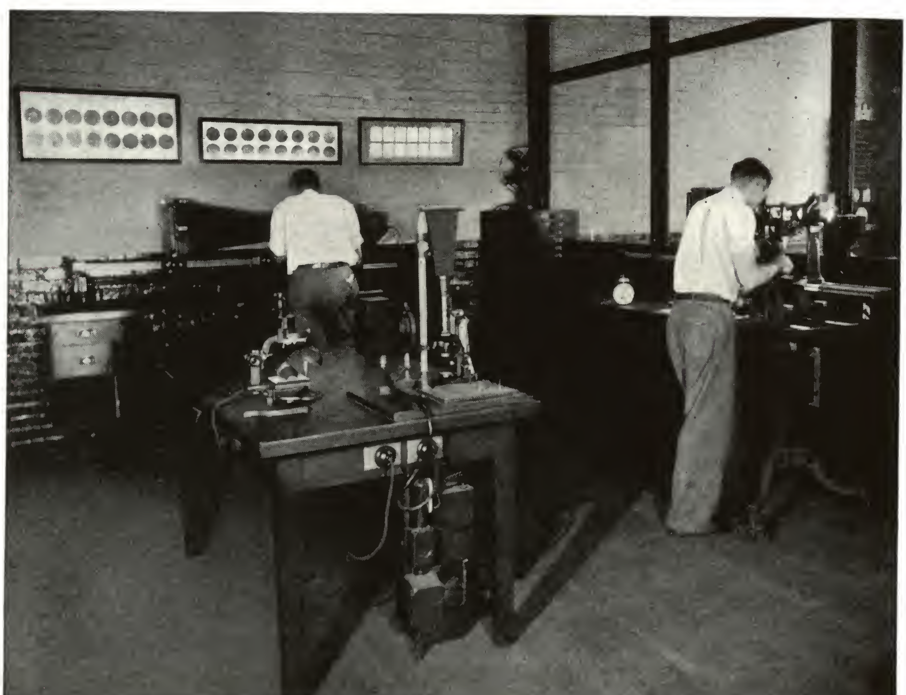
(*b*) Sizes Nos. 5 to 8 may be considered "fine-grained" steels and are generally characterized by incomplete carbide envelopes in the hypereutectoid zone.

(*c*) Size No. 5 may be considered as either a "coarse-grained" or "fine-grained" steel depending on whether those relatively few grains of the hypereutectoid zone which are outside of the No. 5 range are mostly coarser or finer than No. 5.

(*d*) The hypo-eutectoid zone is included as an aid in determining grain size. It also gives an indication of hardening characteristics. In the hypo-eutectoid zone, the condition of the ferrite will follow the same trend as the carbide in the hypereutectoid zone. Size No. 1 will usually show a maximum tendency for ferrite envelopes, while size No. 8 will usually show a maximum tendency for ferrite islands.

Note.—With the present state of the art of steel making, the size ranges Nos. 1 to 5 and Nos. 5 to 8 are suggested as standards for specifications.

This scheme of classification is applicable to all S. A. E. and allied structural steels.



Metallographic examination

GRAIN SIZE CHART FOR CLASSIFICATION OF STEELS

Up to 1½ grains per sq. in.

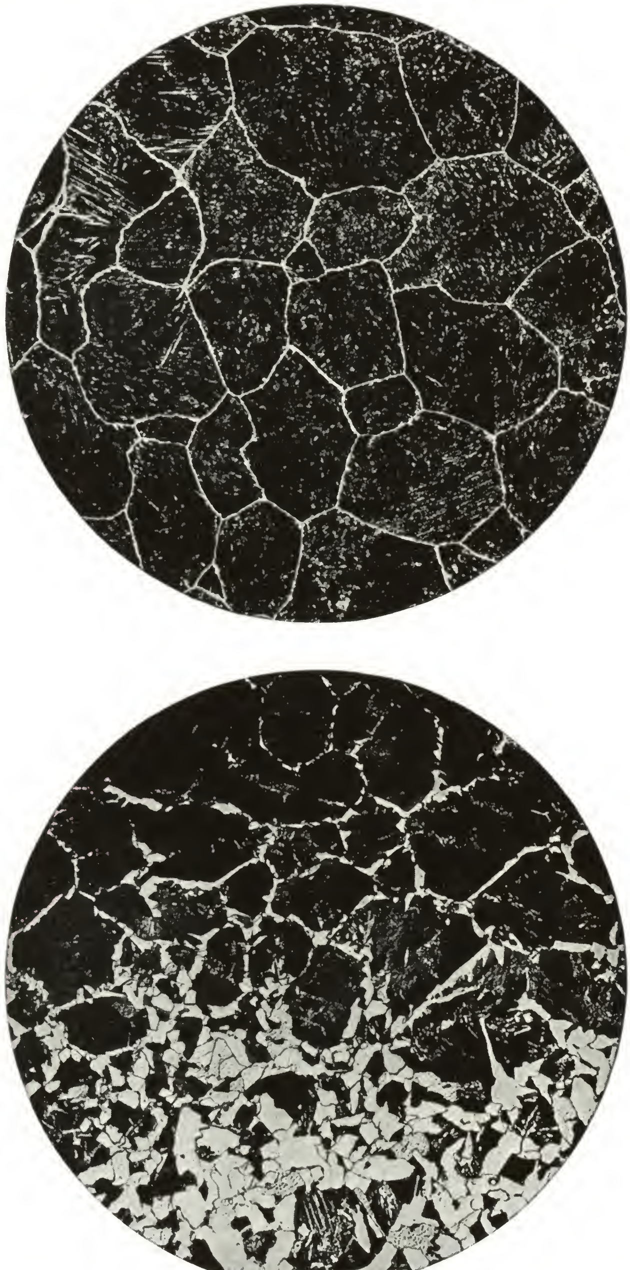
No. 1

Samples carburized at 1700° F. (927° C.) for 8 hours (X 100). Upper and lower photomicrographs refer to hyper- and hypo-eutectoid zones, respectively, of the case.

GRAIN SIZE CHART FOR CLASSIFICATION OF STEELS

$1\frac{1}{2}$ to 3 grains per sq. in.

No. 2



Samples carburized at 1700° F. (927° C.) for 8 hours (X 100). Upper and lower photomicrographs refer to hyper- and hypo-eutectoid zones, respectively, of the case.

GRAIN SIZE CHART FOR CLASSIFICATION OF STEELS

3 to 6 grains per sq. in.

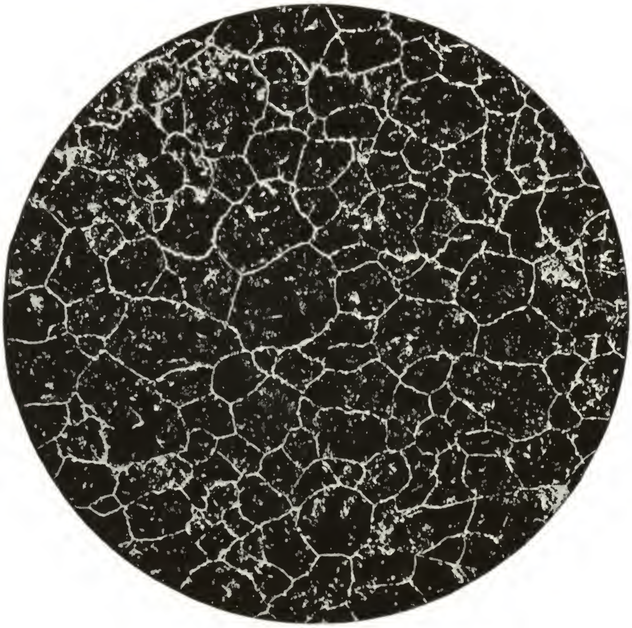
No. 3

Samples carburized at 1700° F. (927° C.) for 8 hours (X 100). Upper and lower photomicrographs refer to hyper- and hypo-eutectoid zones, respectively, of the case.

GRAIN SIZE CHART FOR CLASSIFICATION OF STEELS

6 to 12 grains per sq. in.

No. 4

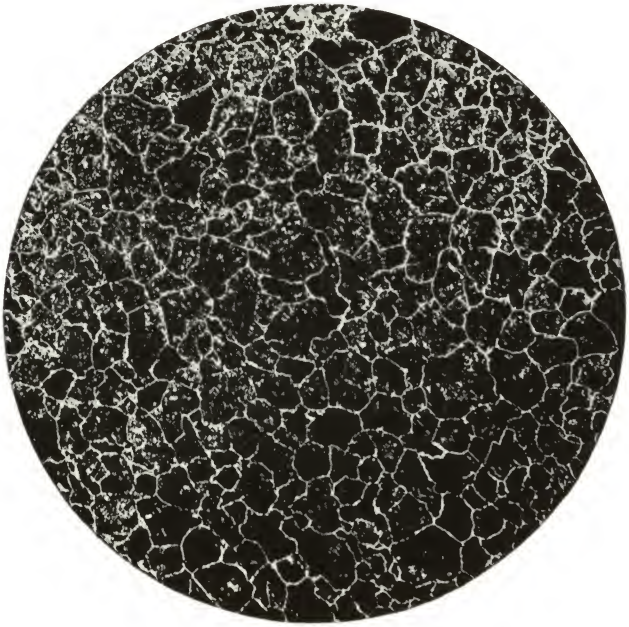


Samples carburized at 1700° F. (927° C.) for 8 hours (X 100). Upper and lower photomicrographs refer to hyper- and hypo-eutectoid zones, respectively, of the case.

GRAIN SIZE CHART FOR CLASSIFICATION OF STEELS

12 to 24 grains per sq. in.

No. 5



Samples carburized at 1700° F. (927° C.) for 8 hours (X 100). Upper and lower photomicrographs refer to hyper- and hypo-eutectoid zones, respectively, of the case.

GRAIN SIZE CHART FOR CLASSIFICATION OF STEELS

24 to 48 grains per sq. in.

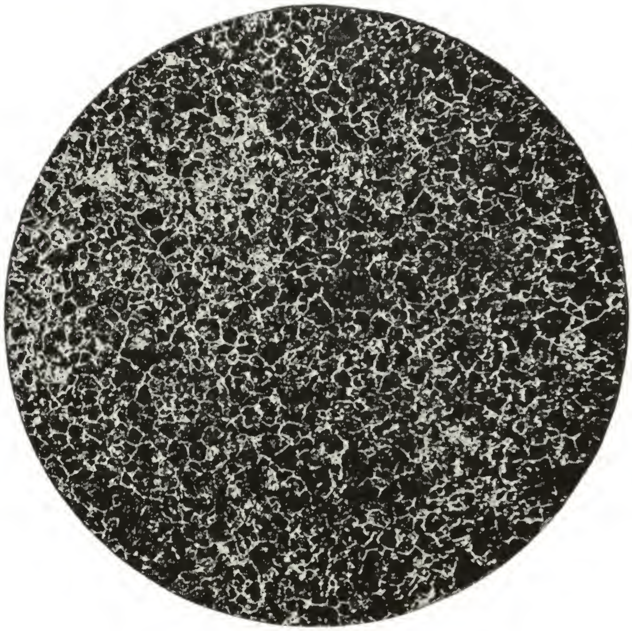
No. 6

Samples carburized at 1700° F. (927° C.) for 8 hours (X 100). Upper and lower photomicrographs refer to hyper- and hypo-eutectoid zones, respectively, of the case.

GRAIN SIZE CHART FOR CLASSIFICATION OF STEELS

48 to 96 grains per sq. in.

No. 7



Samples carburized at 1700° F. (927° C.) for 8 hours (X 100). Upper and lower photomicrographs refer to hyper- and hypo-eutectoid zones, respectively, of the case.

GRAIN SIZE CHART FOR CLASSIFICATION OF STEELS

96 grains and more per sq. in.

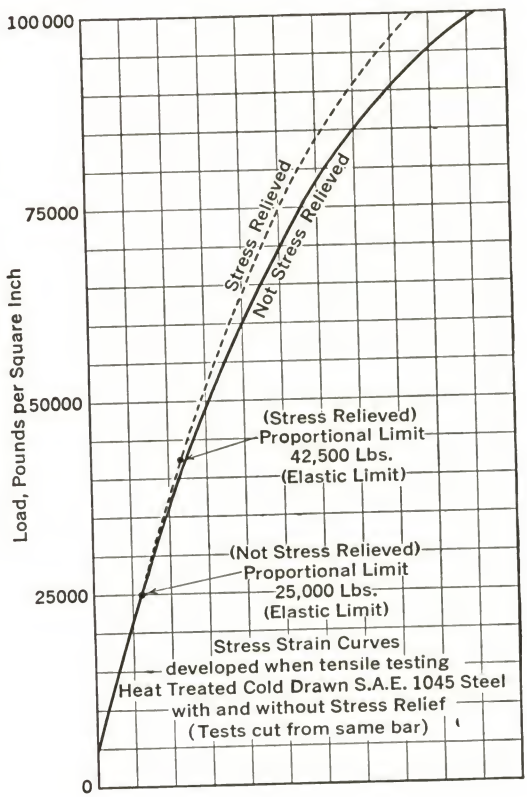
No. 8

Samples carburized at 1700° F. (927° C.) for 8 hours (X 100). Upper and lower photomicrographs refer to hyper- and hypo-eutectoid zones, respectively, of the case

EFFECT OF COLD DRAWING ON TENSILE PROPERTIES OF CARBON STEEL

THE curve shown on page 216 indicates the approximate properties to be anticipated from cold-drawn carbon steel bars up to 1 inch cross section and having 110,000 pounds per square inch tensile strength, or less.

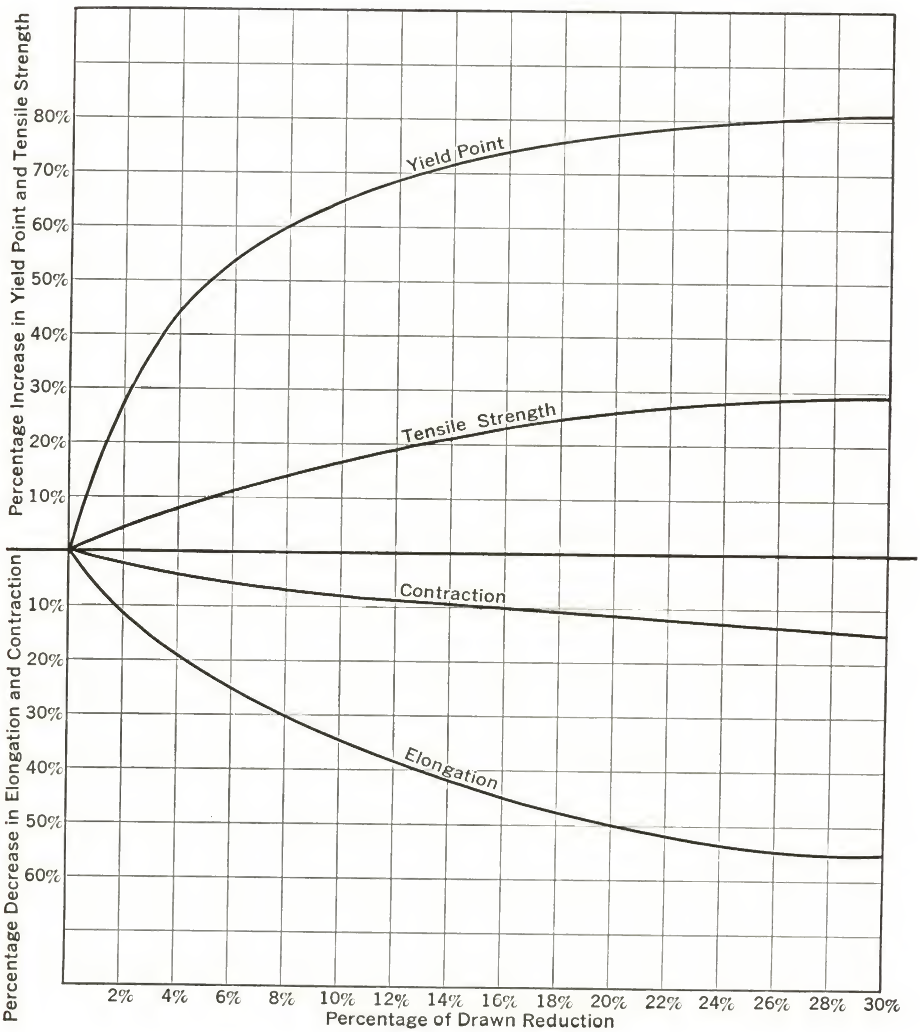
The Yield Point curve is based on the material being in the "as-rolled" or "annealed" condition prior to cold drawing. If the material has been quenched and drawn, the percentage of increase will be lower. This curve, however, does not represent the percentage increase in Elastic Limit in the "as-drawn" condition which usually is not increased by the operation unless a stress relief anneal at about 900° F. is carried out. With this low anneal the elastic limit is raised as shown by the curve on this page and closely approaches the yield point.



The tensile strength curve on page 216 shows the percentage increase in tensile strength. This is not materially changed by the condition of the steel prior to drawing.

The curves on page 216 showing the percentage decrease in elongation and reduction of area are not materially changed by the condition of the steel prior to cold drawing.

EFFECT OF COLD DRAWING ON TENSILE PROPERTIES OF CARBON STEEL



EFFECT OF SIZE OF TEST BAR IN TENSILE TESTING

VARIATIONS in size of tensile test bars cause no serious trouble in determining the strength of the steel as indicated by the tensile strength, yield point, or elastic limit values, or the reduction of area. They do, however, have a marked effect on the percentage of elongation values obtained, as shown below and on page 218.

0.25% Carbon Steel, Annealed

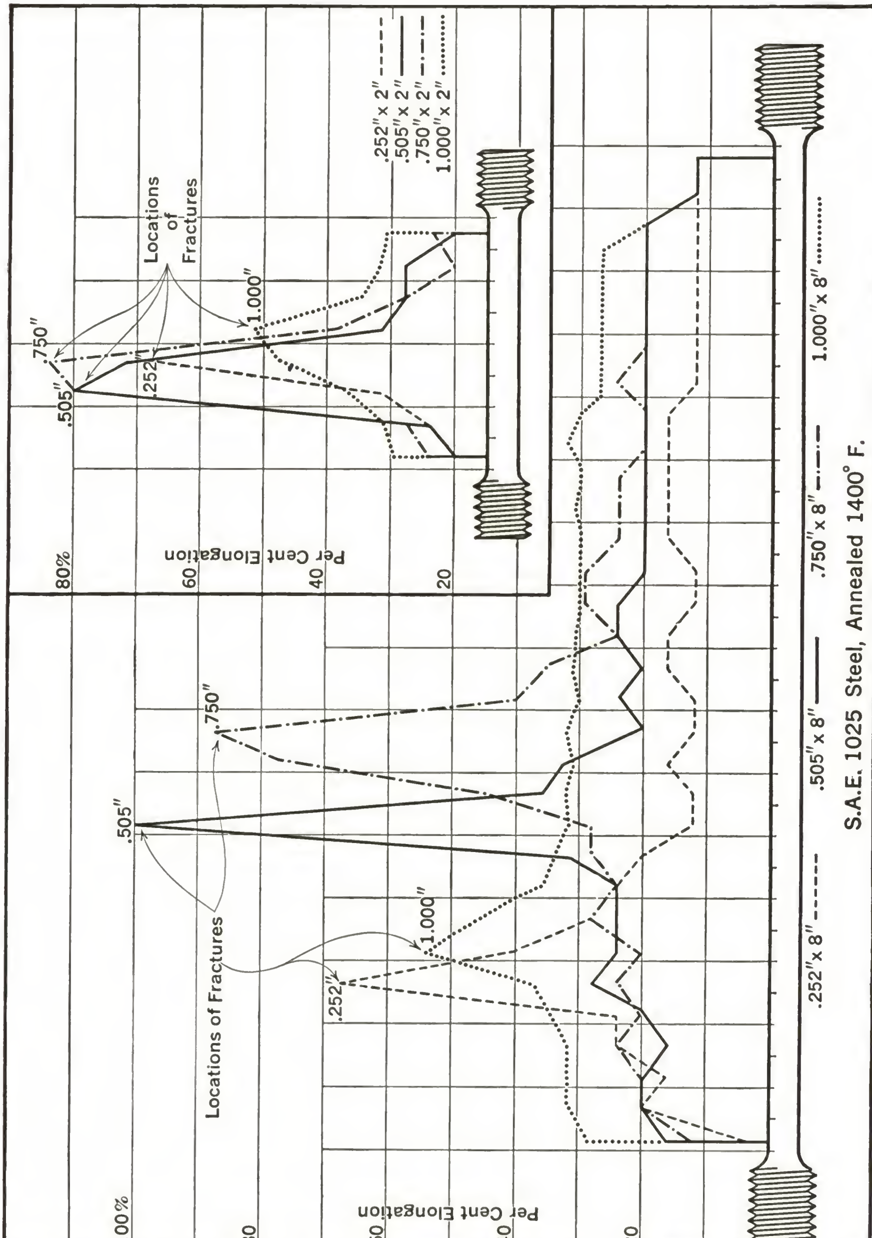
Size of Tensile Test Bar	Elongation in per cent measured over 1″	2″	4″	6″	8″	Reduction of Area in per cent
0.252″ x 2″	42.0	32.5				66.98
0.505″ x 2″	52.0	38.0				61.33
0.750″ x 2″	59.0	41.0				61.05
1.000″ x 2″	68.0	48.0				67.75
0.252″ x 8″		28.0	21.7	19.1	17.6	66.08
0.505″ x 8″		36.0	29.0	26.6	24.5	62.79
0.750″ x 8″		45.0	34.5	30.6	27.5	61.39
1.000″ x 8″		55.0	37.0	32.2	29.2	64.00

A list of the diameters and gage lengths of machined round tensile test bars is given by the S. A. E. as follows:

Original Size of Bar	Gage Diameter	Gage Length
Over ¾″ (Standard)	0.505″	2.0″
½″ to ¾″	0.375″	1.5″
⅜″ to ½″	0.250″	1.0″
¼″ to ⅜″	0.125″	0.5″

Section of one of the physical testing laboratories showing hydraulic machines for tensile testing machined test specimens

EFFECT OF GAGE LENGTH OF TEST BAR IN TENSILE TESTING



EFFECT OF MASS ON PROPERTIES OF HEAT-TREATED STEEL

AS THE size of a part subjected to heat treatment increases, the effectiveness of the cooling operation decreases. To overcome this, it is customary to increase the quenching temperature somewhat as size increases. However, this change does not balance the loss in properties shown by test bars taken at the midway location or along the central axis of large parts.

This is noticed in either the strength as measured by the elastic limit, yield point and tensile strength; or in the ductility as recorded by the elongation and reduction of area. Which of these is affected depends quite naturally on the drawing temperature.

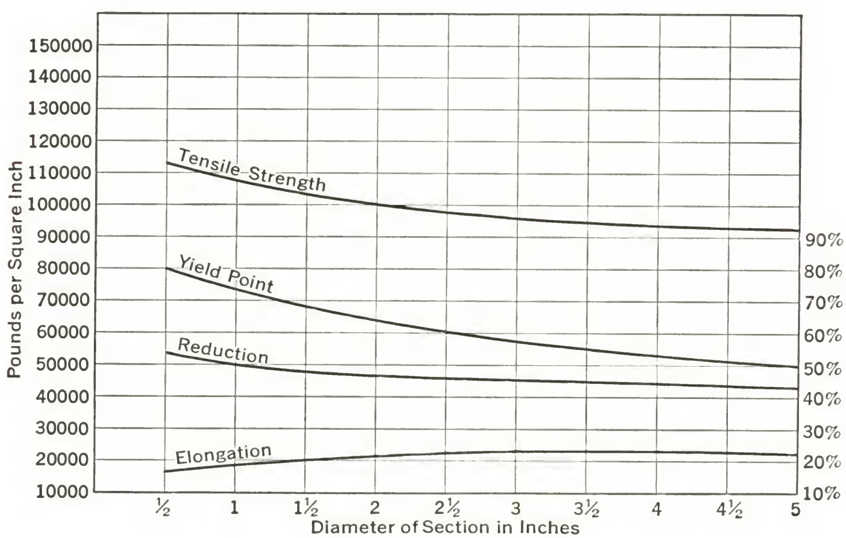
The following curve shows these changes when the drawing temperature is held constant.

While combinations of high physical properties can be developed in small parts, as the size increases care must be exercised. The center of a large mass of steel is only partly susceptible to the effect of drastic treatment and non-uniformity may result.

A steel with sufficient hardening elements to permit a high drawing temperature is necessary to avoid internal strains. It would be fool-hardy to treat a lean or alloy-free part of large section to develop maximum properties by a drastic liquid quench and a low draw. Under this condition it is possible in some cases that the severe strains caused by the drastic quenching operation would not be relieved by a low draw. Tests taken near the surface may indicate that the heat treatment was successful but in the center of the mass where the strength is lower, the unrelieved strains may be of such magnitude that they will entirely counteract the benefits of the heat treatment. The part may actually be in worse condition for service than prior to quenching.

In general, liquid quenching is not advisable for solid steel parts larger than eight inches in thickness. This size can safely be exceeded if the part is hollow when treated. Tables on pages 372, 373 and 374 show relatively little loss of strength for bored shafts as compared with solid shafting.

The purpose of this warning is not to condemn liquid quenching as an unsuitable method for heat treatment but rather to urge discretion in its application and care in selection of the steel. There are specifications for very large parts, whose size is beyond the scope covered by this book, which forbid liquid quenching because of the danger of unrelieved stresses and non-uniformity. These large parts are highly stressed in dynamic service and the best material, when mass is considered, is one having a composition which is capable of developing good physical properties without drastic treatment. A very large-section part, when properly treated by a combination normalizing and annealing, will have the best characteristics for service. While the physical properties as demonstrated by tensile tests may be disappointingly low when compared with the highest values obtained for the same composition treated and tested in small sections, the actual factor of safety will be higher than would be the case were the heavy part drastically treated for higher physical properties.



S.A.E. 1045, oil quenched at 1500° F., drawn at 1000° F.

ENDURANCE STRENGTH OF STEEL

IT HAS been found in laboratory tests for endurance or fatigue that the only property of carbon steel, usually measured, which bears any relation to the endurance strength, is tensile strength. The general relation is shown on the curve. In service, other factors enter which cannot be duplicated by the laboratory. The laboratory tests, therefore, show the values obtained only under ideal conditions, which in practical application may be misleading.

These tests are always carried out on a carefully machined specimen, polished to obliterate even microscopic scratches as far as possible, otherwise the results would be erratic and misleading. The test bar further is either very gently tapered or curved so that no localized concentration of stresses can be set up while the test is being performed. The tests are run dry, for if water, acid, or in some cases gases, were present, they would exert an oxidizing or corrosive effect on the test bar, and the results obtained would be appreciably poorer.

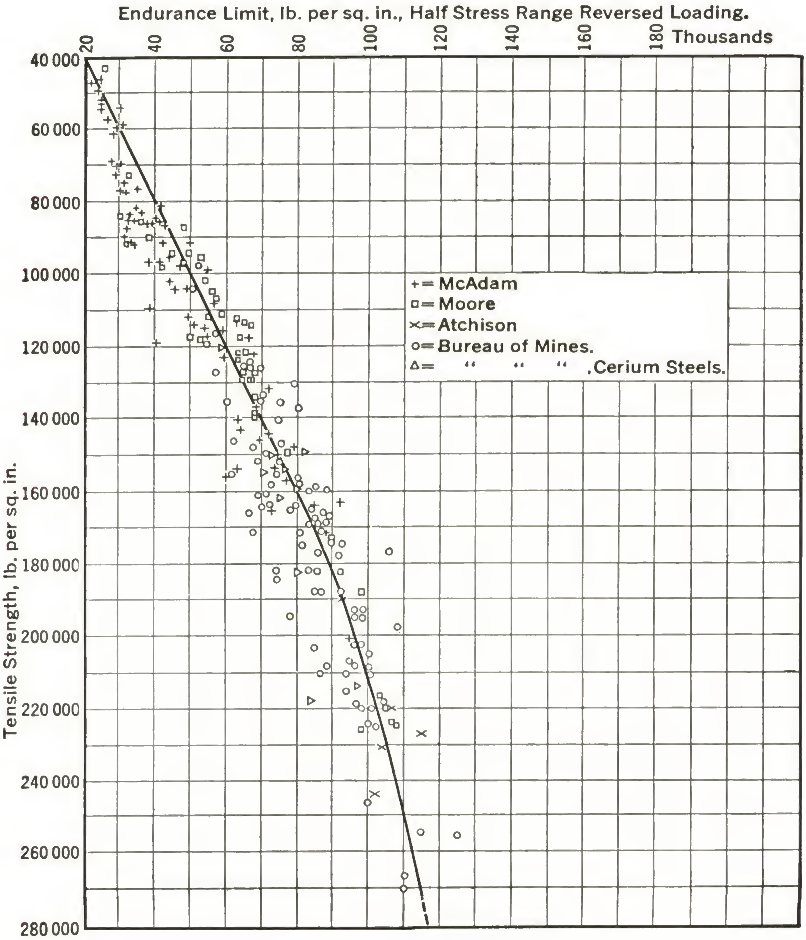
In service the commonest causes of failures are those of the fatigue type. Such failures are usually progressive. Starting at the location of maximum stress concentration as a small parting of the metal, it continually increases in area until failure occurs. The appearance of the fracture is generally a series of concentric rings or waves radiating from the nucleus.

In service, especially on parts subjected to reversal of stresses or vibration, every means should be employed to eliminate localized stresses. Stress concentration is caused by sharp corners, tool marks, cracks or other sharp partings of the metal, improper design or misalignment. Non-uniformity in strength resulting from thermal operations such as "building up" by welding without subsequent annealing, or junctions of deeply hardened metal from partial immersion in quenching, have also caused trouble of this nature.

In parts of non-symmetrical shape, if the alternating stresses are of high intensity, care must be exercised in hot forming so that the flow lines conform to the contour of the part and are not broken or cut to a great degree during the machining

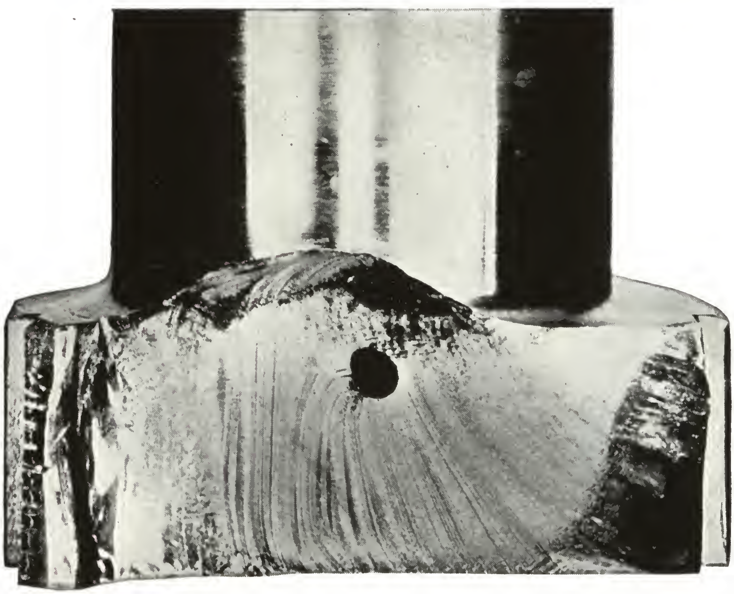
operation. As an example, the flow lines of a billet are all parallel to the axis. A crankshaft for a modern airplane engine machined directly from a billet would be doomed to early failure of the fatigue type, due to the fact that the flow lines would run across the "throws" rather than follow the contour of the shaft.

In some cases a cure for fatigue failure can be found by using a different grade of steel, or proper treatment, or improved metallurgical refinement. If the proper steel with satisfactory refinement has been used and the cause is mechanical, it must be remedied mechanically by locating the cause and making the proper changes or corrections in design or assembly.



FATIGUE FAILURES

Failure of a 3-inch bolt, due to a sharp corner in the root of the thread



Failure of an oil engine shaft due to sharp corners in the keyways for a counterbalance

FATIGUE FAILURES

Failure of a 5⅞-inch power shovel shaft, due to tool marks

Failure of a 6½-inch axle built up locally to 8½-inch diameter by welding on an automatic welding lathe. No subsequent treatment was given to relieve thermal stresses and to refine the structure. The low strength and non-uniformity of the welded collar were also contributing factors.

DEFLECTION OF STEEL UNDER STRESS

(MODULUS OF ELASTICITY)

UP TO their elastic limits, all steels regardless of composition, treatment, hardness or other properties will, with a given section and under the same conditions, temporarily deform practically the same amount under the same load. The modulus of elasticity, nearly the same for all steels, controls this phenomenon.

Reference to the physical properties charts shows that the elastic limit is affected by composition and heat treatment. Above the elastic limit, permanent deformation is encountered on release of load. This is observed in the laboratory when using an extensometer in connection with tensile testing.

In design, the usual factor of safety allowed is such that metal is not stressed up to its elastic limit and, therefore, the amount of deflection in service is controlled by the modulus of elasticity. For instance, long rolls for plates or sheets, if turned straight across the working faces, would produce a product thicker at the center than at the edges due to the deflection or bend of the roll while the product was passing through. To overcome this, either backing rolls or a camber greatest at the middle of the working face is used to produce uniform thickness of plates and sheets.

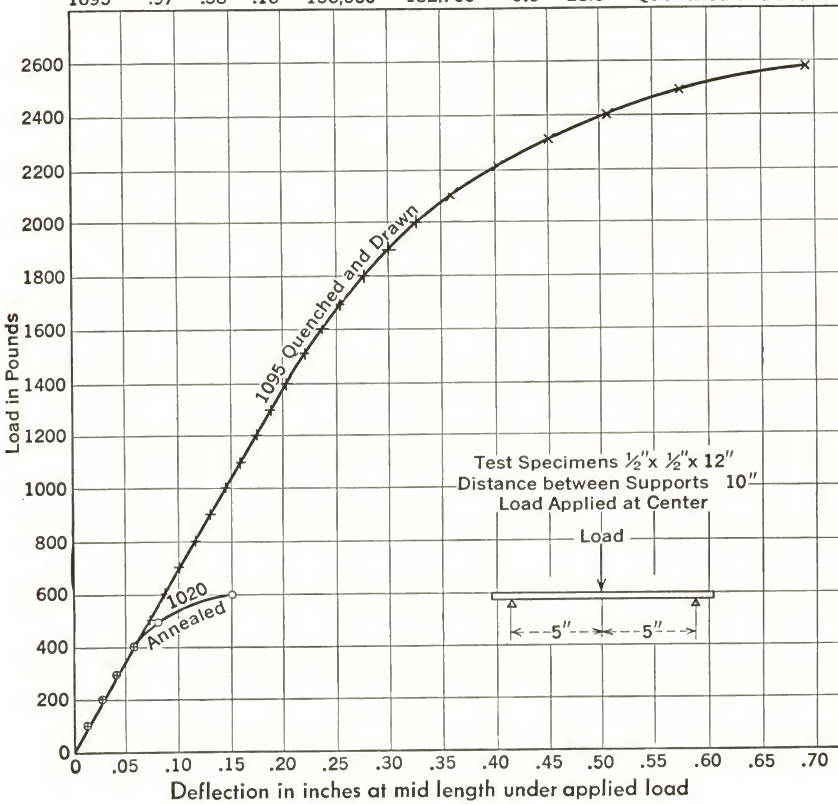
This phenomenon is occasionally overlooked and trouble is encountered in service due to too great an amount of deflection under load. Any changes in the quality of the steel will not correct the situation, which can only be improved by increasing the section so that the unit stress will be lower and thus bring the temporary distortion within limits that are not objectionable.

A clearer picture of this condition may be observed from the curve on page 226 showing the deflection plotted against load in a simple beam test, using for comparison an annealed low-carbon steel, and quenched and drawn carbon spring steel.

DEFLECTION OF STEEL UNDER STRESS

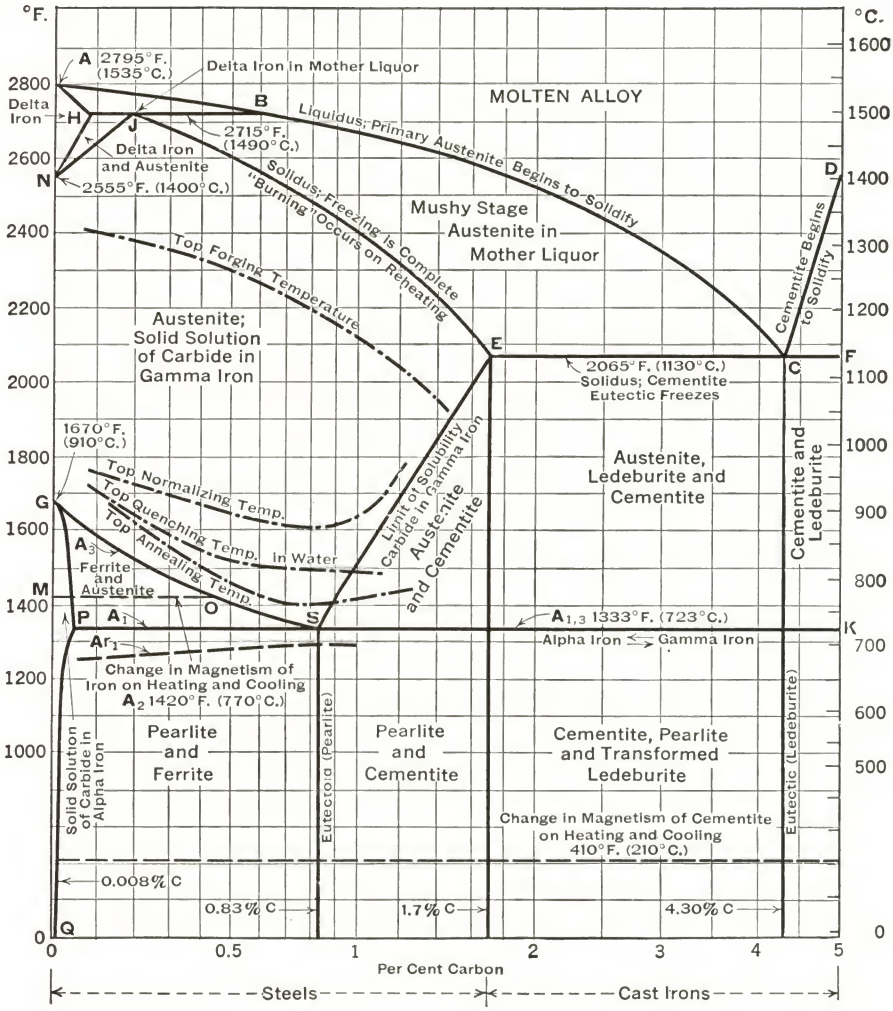
DEFLECTION CURVE OF ANNEALED 1020 and QUENCHED and DRAWN 1095 STEELS

	C.	Mn.	Si.	Elastic Limit	Tensile Strength	Elon.	Red.	
1020	.21	.48	.20	46,000	66,000	23.5	62.	Annealed
1095	.97	.38	.16	136,500	182,700	9.0	21.6	Quenched and Drawn



THE IRON-CARBON DIAGRAM AND ITS APPLICATION

THE iron-carbon, or more correctly the iron cementite equilibrium diagram is based on slowly heated or cooled carbon steels. Those solutions designated as steels fall within the field containing less than 1.7 per cent carbon. When liquid steel is



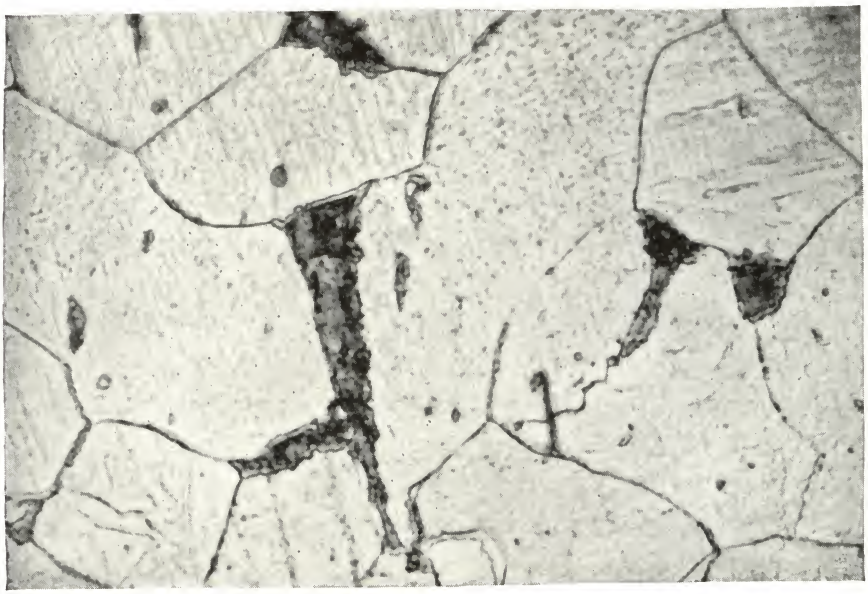
cooled to a temperature that falls on the line A B C, a solid phase begins to appear as crystallites and the amount of solidus increases as the temperature is lowered until finally all liquid has disappeared. In steels containing less than about 0.55 per cent carbon the delta phase is formed directly from the melt, but, as all of the delta phase transforms to the gamma phase or austenite on passing through the line N J, for most purposes, the delta phase may be disregarded and the assumption made that austenite forms directly from the melt even in steels of very low carbon content. Austenite is a solid solution of carbon in a particular form of iron, i.e., gamma iron, which is stable only at high temperatures in the types of steels discussed in this publication and whose atoms are arranged in a face-centered cubic structure. Photomicrographs of austenite in an alloy in which this constituent is stable at ordinary temperatures are shown on page 234.

Immediately after solidification, steel consists of homogeneous austenite, or, in other words, all the carbon is in solid solution. The line J E (or strictly N H J E) is of considerable practical importance because it represents maximum temperatures to which steels can be heated without partial liquefication. The steepness of the line J E shows that to avoid overheating the maximum allowable heating temperature, e.g., when heating for forging, decreases rapidly as the carbon content of the steel increases. This also graphically explains why high carbon steels offer more difficulty in forge welding than is the case with low carbon steels.

It is convenient to divide steels into two groups, hypo-eutectoid and hypereutectoid; the former containing less than approximately 0.9 per cent carbon and the latter more than about 0.9 per cent carbon. When a hypo-eutectoid steel is cooled from within the austenite field, ferrite begins to separate when the line G O S is reached. On further cooling, additional ferrite continues to separate until the remaining austenite has been enriched in carbide to eutectoid composition. The austenite then decomposes at a constant temperature into ferrite and cementite. On slow cooling, ferrite and cementite form a structure known as pearlite, which

FERRITE IN HYPO-EUTECTOID STEEL

100 magnifications



1000 magnifications
(Etched in Nital)
White is ferrite, Dark is pearlite

consists of alternate platelets of ferrite and cementite and shows as the typical thumb print pattern in micrographs. Appearance of pearlite is illustrated on page 232. The ferrite is merely the form of iron stable at low temperatures, body-centered cubic crystals, and contains almost no carbon in solution. Cementite is the compound Fe_3C.

When hypereutectoid steels are cooled from the austenite field, cementite begins to separate when the line E S is reached and on further cooling continues to separate until the remaining austenite has reached the eutectoid composition, after which the austenite decomposes and forms pearlite. Photomicrographs of hypereutectoid steel thus cooled are shown at top of pages 207 to 214.

Slowly cooled hypo-eutectoid steels, see page 229, therefore consist of ferrite and pearlite while hypereutectoid steels consist of cementite and pearlite, see top of pages 207 to 214. A eutectoid steel, page 232, contains nothing but pearlite, which is an intimate mixture of ferrite and cementite, approximately 0.9 per cent carbon.

The line M O, at 768°C. (1414°F.) represents the temperature below which ferrite is magnetic. According to the present conceptions this line does not indicate a phase change.

For convenience in discussion, line P S K is frequently referred to as A_1 line, M O as the A_2 line, G O S as the A_3 line, and E S as the A_{cm} line. Transformation temperatures indicated by the lines just mentioned are usually referred to as "critical points," those observed on cooling being designated as Ar_3, Ar_2, Ar_1 and Ar_{cm}, while those observed on heating are designated Ac_1, Ac_2, Ac_3 and Ac_{cm}.

For annealing, steels are heated above G O S K and slowly cooled. For normalizing, they are heated to the same or slightly higher temperatures and cooled in air. Steels are frequently annealed for prolonged periods at the temperature designated by line P S K. Such annealing followed by slow cooling breaks up the arrangement of the ferrite and cementite platelets in the pearlite grains and causes the cementite to assume the shape of spheroids,

as shown on page 233. Not only is the cementite within the pearlite thus spheroidized but the excess cementite in the boundaries of hypereutectoid steels is also spheroidized.

Most alloy steels, as well as some carbon steels, are heated above G O S K, quenched in either oil or water and then reheated, tempered or drawn, at a temperature below P S K, usually considerably below P S K. Steels thus quenched may show a structure of needle-like character that is indicative of extreme hardness such as is illustrated on page 235. This structure has been named martensite and in this instance was obtained by rapidly quenching a piece of high carbon steel. When quenched steels are tempered or drawn at a temperature below the line P S K, the martensitic structure is decomposed. When drawn at low temperatures a dark constituent frequently is observed at the martensitic grain boundaries that has in the past been popularly identified as troostite, see page 236. This constituent also may appear in quenched steels if the cooling rate in quenching is not rapid enough to retain all of the constituents in the martensitic state. The results of the work of recent investigations indicate that troostite is a finely divided form of pearlite.

When quenched steels are drawn in a temperature range near the line P S K, finely divided cementite particles appear in the form of spheroids as a result of the decomposition of the martensite and resultant structure is called sorbite, see page 237. The properties of steel of this structure are characterized by a good combination of strength and toughness.

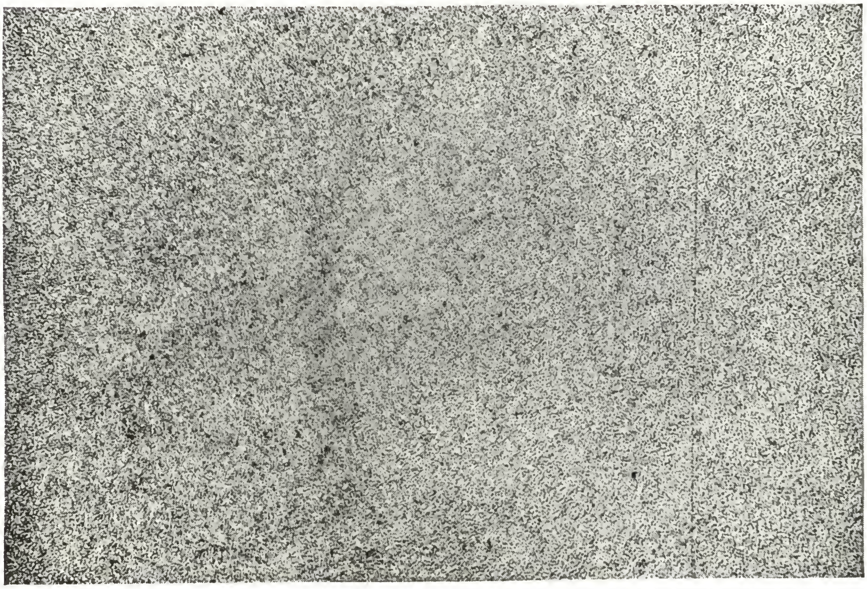
The iron-carbon diagram cannot be used to determine correct heat-treating temperatures for alloy steels; these must be determined by actual experience with particular steels or reference to more complex diagrams of complex alloy systems.

PEARLITE IN EUTECTOID STEEL

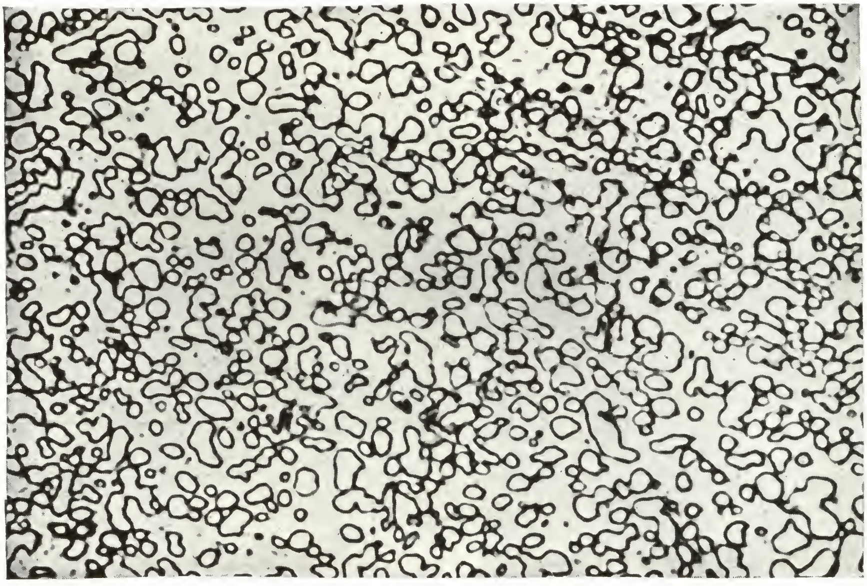
100 magnifications

1000 magnifications
(Etched in Nital)
Alternate platelets of ferrite and cementite

SPHEROIDIZED HYPEREUTECTOID STEEL



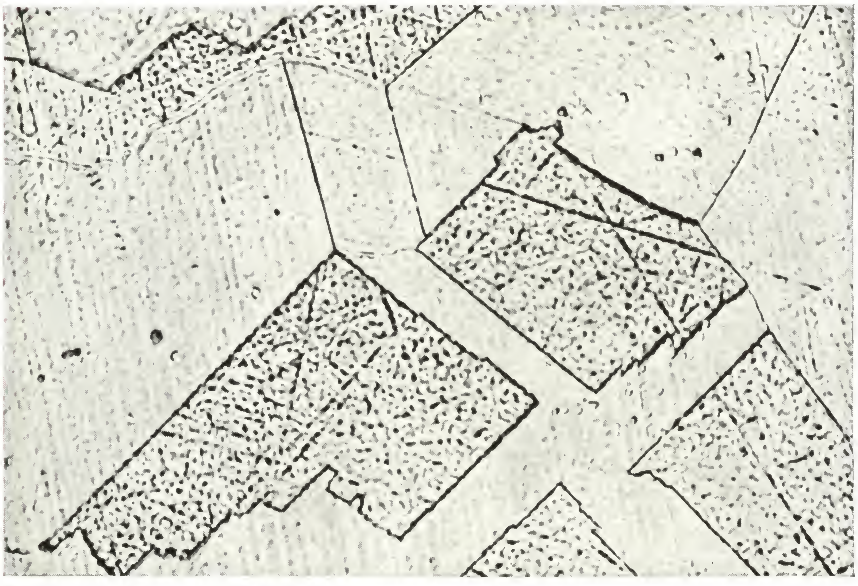
100 magnifications



1000 magnifications
(Etched in Nital)
Islands of cementite in ferrite matrix

AUSTENITIC STEEL

100 magnifications



1000 magnifications

Austenite grains in S. A. E. 30905 steel. Etched in Ferric chloride plus HCl
Representative of annealed 18% Chromium, 8% Nickel steel, 2000° F. water-quenched

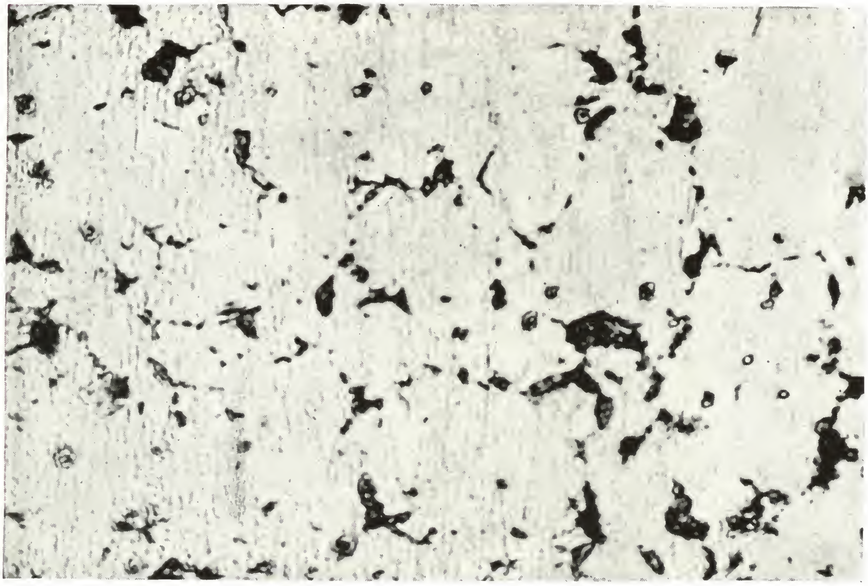
MARTENSITE IN HYPEREUTECTOID STEEL

100 magnifications

1000 magnifications
(Etched in Nital)

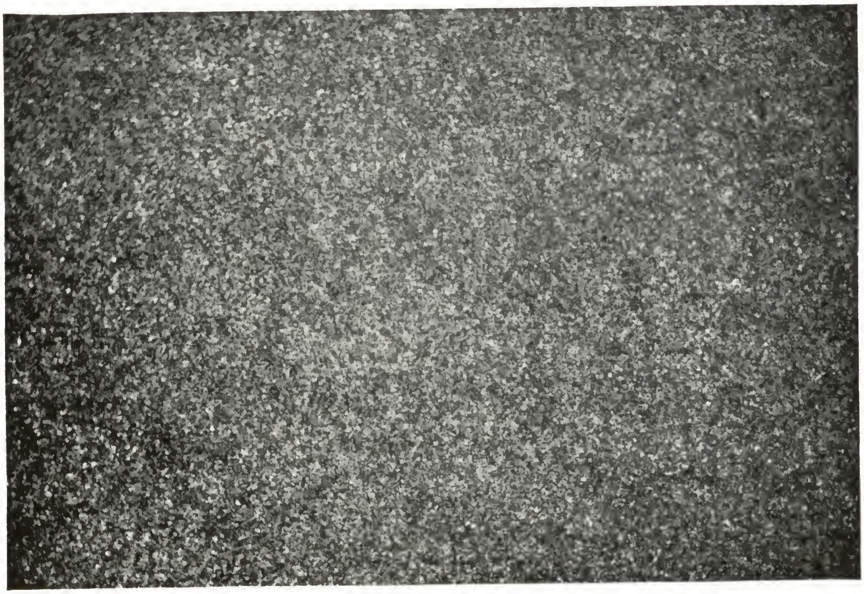
TROOSTITE

100 magnifications

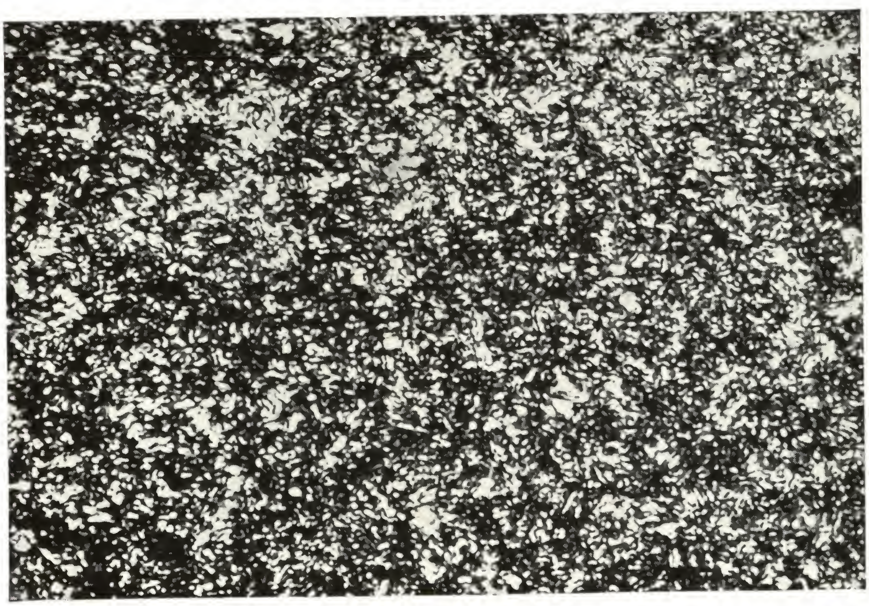


1000 magnifications
(Etched in Nital)
Dark constituent, generally described as troostite, appearing at boundaries of martensitic grains in quenched eutectoid steel

SORBITE IN HYPO-EUTECTOID STEEL



100 magnifications



1000 magnifications
(Etched in Nital)
Alloy steel, quenched and drawn

CHEMISTRY

IN the open hearth, samples for tests for control are taken from the molten metal in the furnace at intervals from the time the charge was melted until it is tapped. While the metal is being teemed from the ladle into the molds at least three samples are obtained, usually after the first and middle ingots are poured and before the last ingot is teemed. These are known as ladle tests and their average gives an accurate representation of the chemical composition of the heat.

Bessemer steel heats are smaller than the usual open hearth heats. Due to the process, no samples for control tests can be taken during the making of the steel. During pouring, at least two ladle test samples are taken, the first when the metal is about one third teemed and the second when the metal is about two thirds poured.

Standard samples used by steel chemists to check against are made available by the United States Bureau of Standards. A standard sample is prepared by securing a sufficient quantity of well mixed chips of the proper size and distributing portions of them to representative laboratories to determine their composition. The results reported, along with those of the Bureau of Standards laboratory, are averaged and these average figures are then adopted as the standard analysis of that particular sample. These figures are then always used in conjunction with this set of standard drillings and both are available for reference.

The variations in the analyses of these samples reported by representative and reputable laboratories therefore present a good cross section of the variations which may be anticipated when careful chemists analyze samples of ideal uniformity. These are known as allowable chemists' errors.

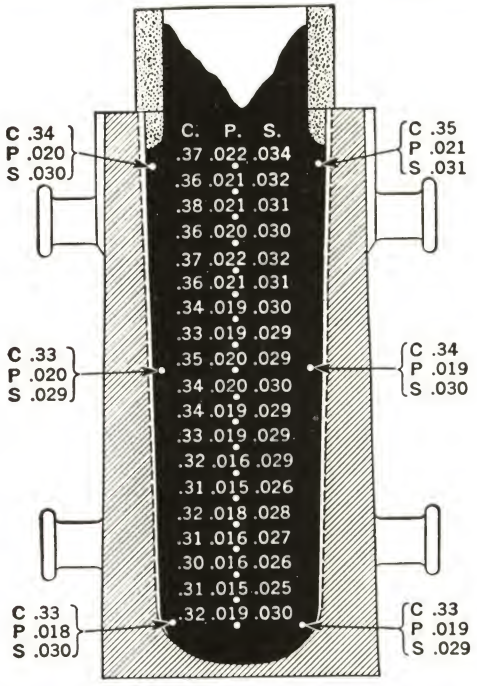
Results reported on some of the grades are as follows:

No. of Laboratories reporting on samples		Reported Analyses				
		C.	Mn.	P.	S.	Si.
8	Min. reported	0.403	0.665	0.043	0.024	0.215
	Max. reported	0.430	0.680	0.045	0.027	0.230
11	Min. reported	0.289	0.439	0.025	0.026	0.117
	Max. reported	0.311	0.466	0.029	0.032	0.132

No. of Laboratories reporting on samples		Reported Analyses—Continued C.	Mn.	P.	S.	Si.
12	Min. reported	0.280	0.644	0.014	0.018	0.130
	Max. reported	0.310	0.659	0.018	0.024	0.140
12	Min. reported	0.480	0.700	0.016	0.009	0.230
	Max. reported	0.503	0.718	0.022	0.015	0.243
12	Min. reported	0.404	0.614	0.013	0.015	0.210
	Max. reported	0.420	0.640	0.017	0.020	0.230

Check analyses taken from blooms, billets, or bars are subject to another variable in addition to the allowable chemists' errors. The molten steel, after it has been poured into the mold, cannot solidify instantaneously, so the phenomenon of selective freezing manifests itself. The resultant ingot when solidified is, therefore, not entirely uniform chemically, and this is the normal state of all steel of commercial sizes and constitutes one of its characteristics.

This variation is found in all ingots. As the size of the ingot increases, the variation is accentuated and cannot be overcome since the steel maker must use ingots of sufficient size to allow for the necessary hot mechanical work. The accompanying illustration shows a chemical survey of an ingot of the size required to properly process a 3-inch bar.



Drillings taken down center line and along sides

Standard methods of chemical analysis have been developed for the determination of each element.

These comments assume that the important function of sampling has been properly carried out. Accurate laboratory analysis is useless if the sample is not representative of the material.

MANUFACTURERS' STANDARD METHODS OF SAMPLING FOR CHECK ANALYSIS OF ROLLED AND FORGED STEEL PRODUCTS

PRINCIPLES TO BE OBSERVED

1. Different parts of a piece of steel vary in composition. This variation occurs principally between the center and the outside of the piece.

2. When a sufficient number of check analyses have been made on samples properly taken to represent the different portions of a melt, their average compares favorably with the ladle analysis which is the analysis of a small test ingot taken during the pouring of the melt.

3. From this it is evident:

(a) That the ladle analysis is more representative of the composition of a melt than any single analysis of the finished material.

(b) That drillings for check analysis, to be representative, should be taken at a point intermediate between the outside and the center of the cross section of the material.

(c) That a sufficient number of pieces should be analyzed to constitute an average that will afford a fair comparison with the ladle analysis.

PREPARATION OF SAMPLES

4. Each melt in a lot shall be considered separately, and pieces for sampling shall be taken to represent the melt as fairly as possible.

5. Samples must be drillings or chips cut by some machine tool without the application of water, oil or other lubricant, and shall be free from scale, grease, dirt or other foreign substances. If samples are taken by drilling, a drill not less than ½ in. nor more than ¾ in. shall be used.

6. Samples must be uniform, well mixed, as fine as possible, and free from dust which causes low-carbon values. Chips too coarse to pass a 20-mesh sieve are not recommended, nor long curly drillings which will not pack closely in the carbon run.

7. In referring samples to the manufacturer or other analysts for check analyses, pieces of the full-size section, when possible, should be submitted rather than cuttings, unless the latter are especially requested.

8. Chemical analysis of material that has been subjected to certain operations does not give results which properly represent its original composition. Therefore samples should be taken from the material in the condition in which it is received from the manufacturer.

LOCATION OF SAMPLES

9. When the material is subject to tension test requirements, samples for check analysis shall be taken from the tension test specimens, or as prescribed in Section 10.

10. When the material is not subject to physical test requirements:

(a) For large sections, including blooms, billets, slabs, rounds, squares, shapes, etc., samples shall be taken at any point midway between the outside and the center of the piece by drilling parallel to the axis. In cases where this method is not practicable, the piece may be drilled on the side, but drillings shall not be taken until they represent the portion midway between the outside and the center. See Fig. 1.

(b) For bored forgings samples shall be taken midway between the inner and outer surfaces of the wall.

(c) For thin material or material of small cross section, such as plates, shapes, bars, etc., if the previous method is not applicable, the samples shall be taken entirely through the material at a point midway between the outside and the center, or by machining off the entire cross section. See Fig. 1.

(d) For sheets the specimen for sampling shall be cut about 2 in. wide, cleaned by pickling or grinding, and then folded once or more by bringing the ends together and closing the bend. The sample for analysis shall be taken in the middle of this length by milling the inside sheared edges or drilling entirely through from the flat surface. Sampling by milling is preferable.

For sheets rolled from slabs or bars longitudinally, the specimen for sampling shall be cut across the full width of the sheet as rolled. For sheets of light gage, more than one specimen may be taken, and stacked together before folding.

For sheets rolled from slabs or bars transversely, the specimen for sampling, about 18 inches long, shall be cut from the side of the sheet and half way between the middle and end as rolled. For sheets of No. 20 gage or lighter, the specimen shall be the full length of the sheet as rolled.

For sheets not of the full size rolled, the sample for analysis shall be taken by milling or drilling the sheet in a sufficient number of places so that the sample is representative of the entire sheet. The sampling may be facilitated by folding the sheet both ways.

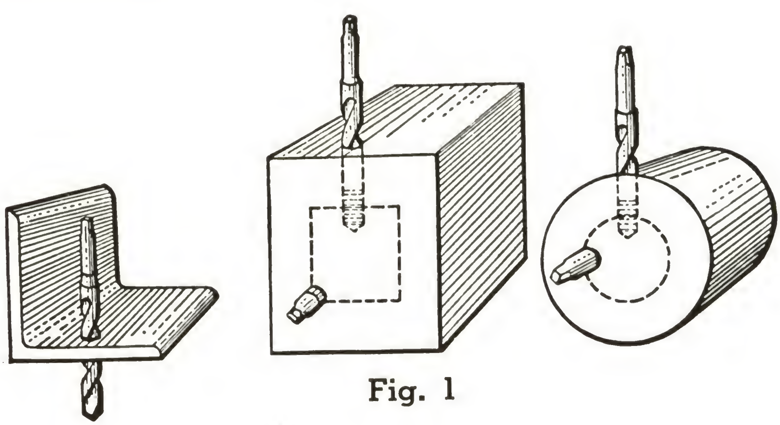


Fig. 1

METHODS OF ANALYSIS

11. Only well-known accurate methods of analysis shall be employed. Carbon shall be determined by the combustion method.

NUMBER OF CHECK ANALYSES

12. (a) Material shall not be subject to rejection for any element or elements unless determinations have been made on the following minimum number of samples from each melt, except as provided in paragraph (b):

3 for 5 tons or less;
4 for over 5 tons to 10 tons;
5 for over 10 tons to 15 tons;
6 for over 15 tons.

(b) If the number of pieces of a melt is less than the number of samples specified in paragraph (a), one sample shall be taken from each piece.

MANUFACTURERS' STANDARD LIMITS FOR CHEMICAL COMPOSITION BASED ON LADLE ANALYSIS

(*As in effect on date of publication of this book.*)

ACID BESSEMER CARBON STEEL

Carbon

	Standard Range
Lowest maximum to be specified 0.08%	
When minimum of range ordered is:	
Up to 0.10%, inclusive	0.05%
From 0.11 to 0.40%, inclusive	0.10%
From 0.41 to 0.60%, inclusive	0.15%
From 0.61 to 0.75%, inclusive	0.20%

Manganese

Lowest maximum to be specified 0.40%	
When minimum of range ordered is:	
Up to 0.35%, inclusive	0.15%
From 0.36 to 0.60%, inclusive	0.20%
From 0.61 to 1.60%, inclusive	0.30%

Phosphorus

Lowest maximum to be specified 0.11%

Sulphur

Lowest maximum to be specified 0.06%	
When minimum of range ordered is:	
Up to 0.075%, inclusive	0.07%
From 0.076 to 0.10%, inclusive	0.08%
From 0.101 to 0.20%, inclusive	0.10%

Silicon

When minimum of range ordered is:	
Up to 0.14%, inclusive	0.10%
From 0.15 to 0.24%, inclusive	0.15%
From 0.25 to 0.40%, inclusive	0.20%

Copper

Minimum only to be specified

MANUFACTURERS' STANDARD LIMITS FOR CHEMICAL COMPOSITION BASED ON LADLE ANALYSIS

(*As in effect on date of publication of this book.*)

BASIC OPEN HEARTH CARBON STEEL

Carbon

Lowest maximum to be specified 0.10%

When minimum of range ordered is:	Standard Range
Up to 0.20%, incl.	0.05%
From 0.21 to 0.50%, incl.	0.10%
From 0.51 to 0.95%, incl.	0.15%
From 0.96 to 1.40%, incl.	0.20%

Manganese

Lowest maximum to be specified 0.40%

When minimum of range ordered is:	Standard Range
Up to 0.35%, incl.	0.15%
From 0.36 to 0.60%, incl.	0.20%
From 0.61 to 1.60%, incl.	0.30%

Phosphorus

Lowest maximum to be specified 0.04%

When minimum of range ordered is:	Standard Range
Up to 0.04%, incl.	0.02%
From 0.041 to 0.05%, incl.	0.025%
From 0.051 to 0.075%, incl.	0.03%

Sulphur

Lowest maximum to be specified 0.05%

When minimum of range ordered is:	Standard Range
Up to 0.075%, incl.	0.07%
From 0.076 to 0.10%, incl.	0.08%

Silicon

When minimum of range ordered is:	Standard Range
Up to 0.14%, incl.	0.10%
From 0.15 to 0.24%, incl.	0.15%
From 0.25 to 0.40%, incl.	0.20%
From 0.41 to 1.80%, incl.	0.40%

Copper

Minimum only to be specified

ACID OPEN HEARTH CARBON STEEL

Carbon

Lowest maximum to be specified 0.10%

When minimum of range ordered is:	Standard Range
Up to 0.20%, incl.	0.05%
From 0.21 to 0.50%, incl.	0.10%
From 0.51 to 0.95%, incl.	0.15%
From 0.96 to 1.40%, incl.	0.20%

Manganese

Lowest maximum to be specified 0.45%

When minimum of range ordered is:	Standard Range
Up to 0.35%, incl.	0.15%
From 0.36 to 0.60%, incl.	0.20%
From 0.61 to 1.60%, incl.	0.30%

Phosphorus

Lowest maximum to be specified 0.05%

Sulphur

Lowest maximum to be specified 0.05%

Silicon

When minimum of range ordered is:	Standard Range
Up to 0.14%, incl.	0.10%
From 0.15 to 0.24%, incl.	0.15%
From 0.25 to 0.40%, incl.	0.20%
From 0.41 to 1.80%, incl.	0.40%

Copper

Minimum only to be specified

MANUFACTURERS' STANDARD PERMISSIBLE VARIATIONS FROM ORDERED CHEMICAL LIMITS BASED ON STANDARD LADLE ANALYSIS RANGES — CARBON STEELS

(*As in effect on date of publication of this book.*)

PROCEDURE I

COMMERCIAL QUALITY REQUIREMENTS

When check analyses are made of the material as furnished, the composition based on the average of all the separate determinations made, may vary from that ordered to the extent permitted in Table I.

TABLE I

Elements	Per cent Under Minimum Limit	Per cent Over Maximum Limit
Carbon—Maximum limits up to 0.80%, inclusive	0.02	0.03
Carbon—Maximum limits over 0.80% to 1.15%, inclusive	0.03	0.04
Carbon—Maximum limits over 1.15%	0.03	0.05
Manganese	0.02	0.03
Phosphorus	....	0.005
Sulphur	....	0.005
Silicon	0.02	0.03
Copper	0.02	....

Variations both under and over apply only when a range is specified.

PROCEDURE II

FORGING QUALITY AND SPECIAL CHECK ANALYSIS REQUIREMENTS

(a) When check analyses are made of the material as furnished, the composition based on the average of all the separate determinations made, shall be within the limits ordered.

(b) The composition of individual samples may vary from that ordered to the extent permitted in Table II, except that when ranges are specified, the carbon, the manganese, or the silicon in any one melt may not vary both above and below the range ordered.

TABLE II

Elements	Per cent Under Minimum Limit	Per cent Over Maximum Limit
Carbon—Maximum limits up to 0.25%, inclusive	0.02	0.03
Carbon—Maximum limits over 0.25% to 0.60%, inclusive	0.03	0.04
Carbon—Maximum limits over 0.60% to 1.15%, inclusive	0.03	0.05
Carbon—Maximum limits over 1.15%	0.03	0.06
Manganese	0.05	0.05
Phosphorus	....	0.01
Sulphur	....	0.01
Silicon	0.02	0.05
Copper	0.02	....

PROCEDURE III

EXTRA RESTRICTIVE CHECK ANALYSIS REQUIREMENTS

(a) When check analyses are made of the material as furnished, the composition based on the average of all the separate determinations made, shall be within the limits ordered.

(b) The composition of individual samples may vary from that ordered to the extent permitted in Table III, except that when ranges are specified, the carbon, the manganese, or the silicon in any one melt may not vary both above and below the range ordered.

TABLE III

Elements	Per cent Under Minimum Limit	Per cent Over Maximum Limit
Carbon	0.02	0.02
Manganese	0.03	0.03
Phosphorus	....	0.005
Sulphur	....	0.005
Silicon	0.02	0.02
Copper	0.02	....

EXCEPTIONS

(a) Standard permissible variations for check analyses are not applicable to rimmed steel.

(b) Rephosphorized and resulphurized steel shall not be subject to check analyses for phosphorus or sulphur.

(c) When both minimum and maximum limits are ordered, giving a range greater than the Standard ladle analysis range; unless otherwise specified by the purchaser, the permissible variations for check analyses shall be applied to the Standard ladle range the mean of which will coincide with the mean of the ordered range. In no case shall an ordered range which includes check analyses limits be less than the sum of the ladle range and the permissible under and over check variations.

COMPOSITION HARDNESS

IF the effect of various contained elements is known, it is possible to anticipate approximately the response of steel to heat treatment under identical conditions. Aside from the chemistry, the other characteristics of the steel developed by melting practice, rolling temperatures, etc., must be similar when comparing steels by this method.

Values which may be used for the various elements are:

Carbon........0.01 %=30	Silicon..........0.01%=5	Vanadium......0.01%=20
Manganese....0.01 %= 8	Nickel..........0.01%=4	Molybdenum...0.01%=16
Phosphorus....0.001%= 4	Chromium.......0.01%=5	Tungsten.......0.01%= 4
Sulphur.......0.001%= 1		Copper.........0.01%= 4

These factor figures have been found useful in comparing heats of steel containing the same elements. They, however, are not infallible when comparing one type of steel with another, since the value of any of these alloying elements varies, depending on whether the effect is of a single element or the combined effect of several elements. This applied more particularly to alloy steels.

As an example of the application of this quick method, compare the hardness factors of S. A. E. 1030 and S. A. E. X1330 using the mean of the analysis range. We find S.A.E. 1030 has a hardness factor of 1719 while S. A. E. X1330 has a hardness factor of 2404.

S.A.E. 1030		S.A.E. X1330	
Carbon............30×30=	900	Carbon........... 30×30=	900
Manganese.........75× 8=	600	Manganese........150× 8=	1200
Phosphorus........23× 4=	92	Phosphorus....... 23× 4=	92
Sulphur...........27× 1=	27	Sulphur..........112× 1=	112
Silicon...........20× 5=	100	Silicon........... 20× 5=	100
	1719		2404

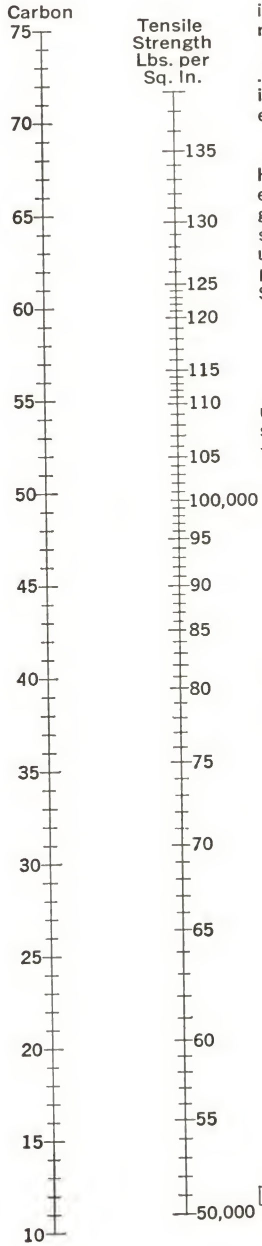
Three different arithmetical methods for obtaining the approximate tensile strength of rolled carbon steel are:

$$T.S.=C\times 650+M\times 90+M\times C\times 4+P\times 1000+38800$$
$$T.S.=C\times 950+M\times 85+P\times 1050+37430$$
$$T.S.=C\times(650+4M)+P\times 1000+M\times 90+38800$$

Note: Move the decimal points two places to the right when substituting numbers which indicate amount of elements, C. M. P.

The chart on page 247 and table on page 248 have been found valuable for finding the tensile strength of rolled carbon steel.

CHART FOR ESTIMATING TENSILE STRENGTH OF ROLLED OPEN HEARTH CARBON STEEL

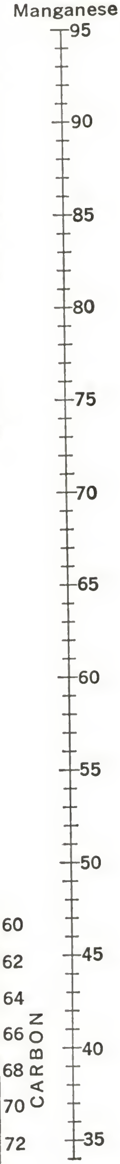


Values are based on tests taken on ¾-inch rounds but are approximately correct up to 3½-inch sections.

Note: When Phosphorus is greater than .02%, the tensile strength should be increased at the rate of 1000 pounds for each .01% that Phosphorus exceeds .02%.

To obtain the Tensile Strength of Open Hearth Steel having Carbon and Manganese content within the range of those given on the two outer scales, place a straight edge across the two known values, and read the resulting value at the point of intersection on the Tensile Strength scale.

Note: The tables given below must be used in preference to the chart for all steels within the analysis range of the tables.



CARBON \ MANGANESE	34	36	38	40	42
60	101980				
	103230				
62	104480				
	105730				
64	106980				
	108230				
66	109710	111770			
	111185	113175			
68	112665	114575			
	114140	115980			
70	115620	117380	119140	120900	
	116795	118605	120410	122220	123205
72	117970	119830	121685	123540	124470
	119150	121050	122955	124860	125730
74	120325	122275	124230	126180	126995
	121500	123500	125500	127500	128260

MANGANESE: 82	84	86	88	90	92	94	96	CARBON
			128000	128000	130000	131000	132000	60
			128880	129800	130730	131655	132585	
			129760	130600	131455	132310	133170	62
			130640	131400	132185	132970	133750	
			131520	132200	132910	133625	134335	64
			132400	133000	133640	134280	134920	
			133240	133800	134390	134985	135575	66
			134080	134600	135145	135690	136230	
			134920	135400	135895	136390	136890	68
			135760	136200	136650	137095	137545	
			136600	137000	137400	137800	138200	70
			137040	137400	137800	138200	138600	
			137480	137800	138200	138600	139000	72
			137920	138200	138600	139000	139400	
	137775	138120	138360	138600	139000	139400	139800	74
137900	138300	138600	138800	139000	139400	139800	140200	

TABLE FOR ESTIMATING TENSILE STRENGTH OF ROLLED BESSEMER STEEL

VALUES ARE BASED ON TESTS TAKEN ON ¾" ROUNDS

Carbon Per Cent	MANGANESE, PER CENT								
	0.35	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10
0.10	64450	64500	65000	65500	65800	.....	.....	.....	.....
0.12	64910	65000	65860	66800	67600	.....	.....	.....	.....
0.14	65370	65500	66720	68100	69400	.....	.....	.....	.....
0.16	66200	66430	67970	69800	71540	73920	75420	77250	.....
0.18	67400	67790	69610	71900	74020	76460	78260	80250	.....
0.20	68600	69150	71250	74000	76500	79000	81100	83250	.....
0.22	71130	71690	73740	76000	78700	80600	82660	84550	.....
0.24	73665	74230	76225	78000	80900	82200	84220	85850	.....
0.26	75940	76600	78475	80050	82750	83900	85800	87480	89220
0.28	77975	78800	80490	82150	84250	85700	87400	89440	90960
0.30	80000	81000	82500	84250	85750	87500	89000	91400	92700
0 32	81600	82500	84100	85550	87410	88900	90560	92440	94020
0.34	83200	84000	85700	86850	89070	90300	92120	93480	95340
0.36	85460	86200	87900	89060	91240	92490	94280	95450	97400
0.38	88380	89100	90700	92180	93920	95470	97040	98350	100200
0.40	91300	92000	93500	95300	96600	98450	99800	101250	103000
0.42	92380	93120	94800	96680	98200	99910	101680	103550	105240
0.44	93460	94240	96100	98060	99800	101370	103560	105850	107480
0.46	94500	95390	97450	99500	101580	103280	105680	108260	110080
0.48	95500	96570	98850	101000	103540	105640	108040	110780	113040
0.50	96500	97750	100250	102500	105500	108000	110400	113300	116000
0.52	99100	100250	102850	105220	108220	110600	113240	115780	118760
0.54	101700	102750	105450	107940	110940	113200	116080	118260	121520
0.56	106900	107900	110500	112940	115740	117960	120700	122800	125920
0.58	114700	115700	118000	120220	122620	124880	127100	129400	131960
0.60	122500	123500	125500	127500	129500	131800	133500	136000	138000
0.62	122900	124100	126220	128400	130500	132880	134980	137600	140200
0.64	123300	124700	126940	129300	131500	133960	136460	139200	142400
0.66	123655	125150	127490	129950	132400	134800	137540	140350	143600
0.68	124100	125450	127870	130350	133200	135400	138220	141050	143800
0.70	124500	125750	128250	130750	134000	136000	138900	141750	144000
0.72	125100	126330	128950	131490	134560	136800	139740	142810	145200
0.74	125700	126910	129650	132230	135120	137600	140580	143870	146400
0.75	126000	127200	130000	132600	135400	138000	141000	144400	147000

HOT ACID ETCHING

THE hot acid etch test is a highly specialized operation used principally as a measure in manufacturing control rather than as an acceptance test. It is usually applied to blooms and billets rather than to small size bars. Standard methods for conducting the hot acid etch test have been published but there are no recognized standards for acceptance or rejection of steel so tested. The ultimate use for which the product is intended must be the guide.

If the hot acid etch test is specified, it is recommended that a thorough understanding regarding acceptability limits be agreed upon by the parties interested.

To carry out this test, a cross section disc ranging from ½ to 1 inch in thickness is used. If the machine or saw cut is smooth, no additional preparation is necessary; if not, a smooth milling cut should be taken across the surface, or as an alternate, the face should be ground.

The specimen should then be immersed in a hot acid solution (usually HC*l*, approximately 1.08 specific gravity). The time required in the acid depends on the analysis of the steel being

Samples from every heat of special requirement steels are hot acid etched

tested, the mass of the specimen, the conditions to be studied, and other mechanical or thermal conditions. Carbon steels generally require a shorter time than alloy steels. The time required to properly etch the sample ranges from 30 to 45 minutes. It is recommended in carrying out this test that the sample be removed occasionally from the acid etch bath and inspected to see if it has been sufficiently etched and, further, to prevent over-etching which gives erroneous results. The variations that may be expected due to improper etching time are shown by illustrations on pages 251 to 253.

Page 251 shows sample A, a billet of uniform macrostructure, and sample B, a billet of non-uniform macrostructure, both etched ten minutes.

Page 252 shows the same two samples etched the proper time for the grade of steel.

Page 253 shows the same two samples etched a longer period.

It is obvious that when properly etched, the uniform sample A is superior to B, but when over-etched the non-uniform sample B appears to be nearly as uniform as sample A.

This test, when properly carried out, gives valuable information regarding the internal condition of the steel. Improper procedure or wrong interpretation may mean either approval of steel not up to the standard desired, or rejection of steel which is entirely suitable.

Some of the conditions of steel which are shown by this etch test are illustrated on pages 254 to 256. These illustrations are not presented to define in any sense suitable or non-suitable material but are used only to amplify the comments on hot acid etching.

HOT ACID ETCH TEST EXAMPLES

A

Etched 10 minutes

B

Etched 10 minutes

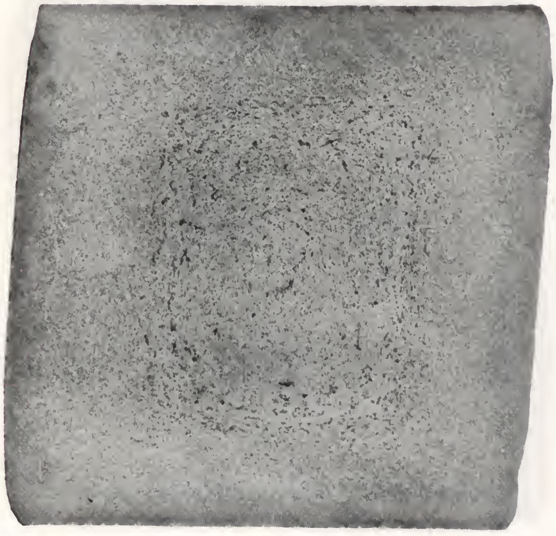
Photographs of hot acid etched 4-inch billets

HOT ACID ETCH TEST EXAMPLES

A

Properly etched

B



Properly etched

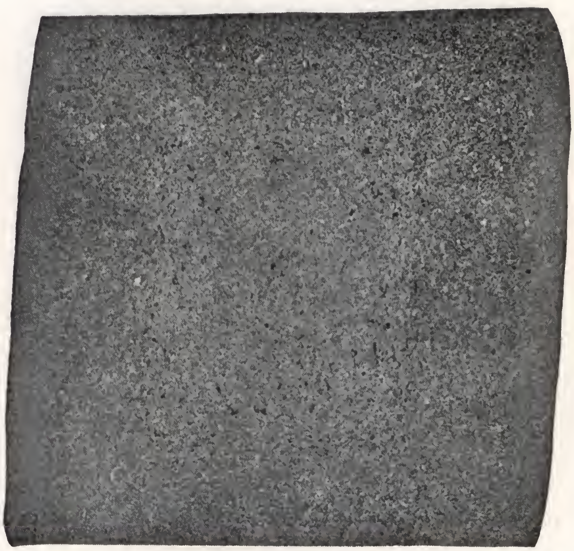
Photographs of hot acid etched 4-inch billets

HOT ACID ETCH TEST EXAMPLES

A

Over etched

B



Over etched

Photographs of hot acid etched 4-inch billets

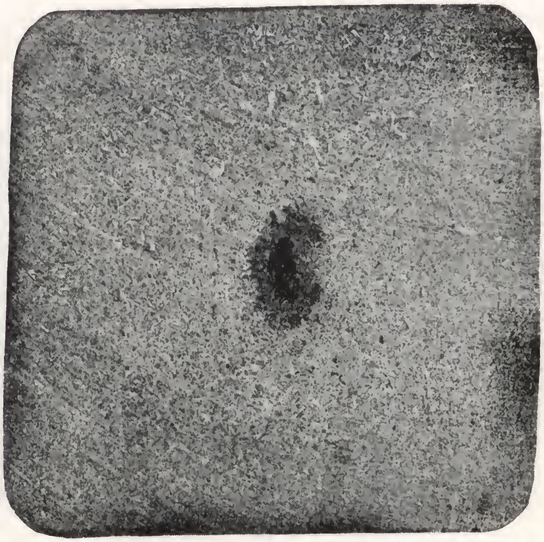
HOT ACID ETCH TEST EXAMPLES

Showing mold pattern

Showing rimmed steel

Photographs of hot acid etched 4-inch billets

HOT ACID ETCH TEST EXAMPLES

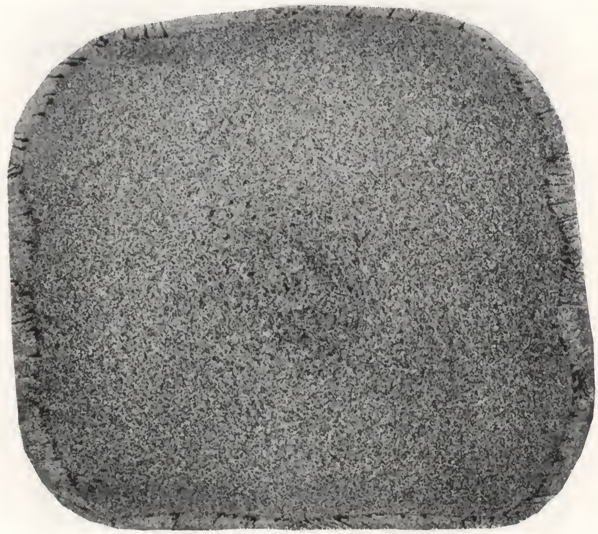


Showing segregation and pipe

Showing deoxidized steel

Photographs of hot acid etched 4-inch billets

HOT ACID ETCH TEST EXAMPLES



Showing porosity due to mold action

Showing internal cracks

Photographs of hot acid etched 4-inch billets

TENSION TEST TERMS

THE tension test of steels consists of applying a pulling force to a specimen of material and recording the reactions that occur. In steel, these reactions occur in two distinct phases; the elastic phase wherein the material is not permanently deformed by the pulling force, and the plastic or yield phase wherein the material becomes either permanently deformed or ruptured.

For the service use of material, the greatest concern is that the maximum force or load encountered shall always be within the elastic range. The terms used for expressing the limiting value of the elastic range have in the past been very loosely applied, leading to confusion as to the degree of precision contemplated by the writers of specifications. Therefore, it appears pertinent to define these terms in the order of their occurrence in testing, which are: proportional limit, elastic limit, proof stress, yield strength and yield point.

PROPORTIONAL LIMIT

The proportional limit of a material is the load per unit area beyond which the increases in strain cease to be directly proportional to the increases in stress. In the tension test, the specimen is placed in the testing machine with an extensometer attached. If accurately measured loads are progressively applied and the resultant strain movements recorded, and if these data are plotted as the ratio of load to strain, it will be found that up to a certain point this ratio will be practically a straight line. The load value at this point represents the proportional limit of the material, or the limit of proportionality of stress to strain. Within this limit, the ratio of unit stress to unit strain is called the *Modulus of Elasticity*. The graph from which these values are obtained, may be plotted from observed and recorded data or it may be autographically drawn by an automatic recorder.

The proportional limit, as described above, is used mainly in research investigations and has very few commercial applications. The test procedure is tedious and requires very delicate instruments and highly trained operators.

ELASTIC LIMIT

The elastic limit of a material is the greatest load per unit area which will not produce a measurable permanent deformation after complete release of load.

This value lies somewhere above the proportional limit and below the yield values. According to a strict interpretation of the definition, it can only be obtained by repeated loading and unloading of increasing loads by measured increments of stress and noting the permanent elongation, if any, after each release of load. The maximum load, thus found, not producing a measurable elongation after complete release would thus be the elastic limit.

This method of test, however, as indicated both by published and private data, is impractical, tending to produce variable elastic limit values due to slippage, cold working, etc., in carrying out the test. It is therefore recommended that when elastic limit values are desired, that they be obtained by plotting a stress-strain curve in the same manner as described under proportional limit, either from observed or autographically recorded data, and the elastic limit value be taken as the load per unit area, corresponding to the point at which the stress-strain curve departs from the modulus line in excess of a previously agreed limiting amount.

PROOF STRESS

The proof stress of a material is that load per unit area which a material is capable of withstanding without resulting in a permanent deformation of more than a specified amount per unit of gage length after complete release of load.

The definition of this value also states that it shall be determined by repeated applications and releases of measured increments of load. The suitability of proof stress determinations of elastic properties in connection with practical testing is dependent entirely on the amount of permissible permanent elongation specified. In cases where the allowable permanent elongation is less than 0.01 per cent of gage length, the same remarks apply as were given under elastic limit.

YIELD STRENGTH

The yield strength is the load per unit area at which a material exhibits a specified permanent deformation or a specified elongation under load.

This value may be determined in the same manner as has been suggested for determining elastic limit except that the specified amount of departure of the stress-strain curve from the modulus line is usually 0.1 per cent to 0.2 per cent of the gage length. It may also be obtained by any one of the following methods:

Proportional Method—The yield strength shall be calculated at the reading last preceding the first increment of load which produces an increment of strain which clearly exceeds twice the increment of strain taken from the modulus line.

Extension Under Load Method—The yield strength shall be the unit applied load at which the material exhibits the specified extension under load. It shall be determined by applying the extensometer to the test specimen when there is no load on the specimen, and then increasing the load, taking readings at approximately 75 and 90 per cent of the specified elongation and at the specified elongation. If the stress at the specified elongation

Tension tests. Measuring elongation

Tension tests. Measuring reduction

equals or exceeds the specified yield strength the material is acceptable as to yield strength.

The Divider Method—This is the same as that described below for determining the yield point by use of dividers or a strainometer.

YIELD POINT

The yield point is the load per unit area at which a marked increase in deformation of the specimen occurs without increase of load, or in other words, the yield point is the stress at which there occurs a marked increase in strain without an increase in stress.

Since the speed of testing influences the results, this feature must be taken care of by keeping the crosshead speed of the testing machine (or the rate of application of the load) within well defined limits. A. S. T. M. (E8-33) recommends that in determining yield strength, the crosshead speed for the 2-inch gage length shall not exceed 0.125 inch per minute.

The yield point is usually determined by one of the following two methods:

Drop of Beam—In this method the load is applied at a steady rate with the beam kept in balance by running out the poise weight at a steady rate. When the yield point is reached the increase in the rate of strain causes an interruption in the rate of load application (for some metals there is an actual falling off of load) and the beam of the testing machine drops for a brief but appreciable period of time. The load at the drop of beam (or halt of gage in hydraulic-type machines) is recorded and that stress taken as the yield point of the material being tested. In case the testing machine is fitted with a self-indicating load measuring device, there is a sudden halt of the load-indicating pointer, corresponding to the drop of beam.

Divider Method—A pair of dividers are set exactly to the distance between centers of the gage marks. With a small initial load on the specimen, one arm of the dividers will be centered in one gage mark and the other arm is held against the other gage mark. When any movement of the gage mark with respect to the free arm of the divider can be detected by the eye, the applied load is noted. The applied load divided by the area of the original cross section of the test specimen is taken as the yield point. A strainometer may be used in place of the dividers. This method should be used only where the distance between gage marks is not greater than 2 inches. Longer gage lengths are liable to lead to erroneous results, especially in materials of relatively high yield point.

TENSILE STRENGTH

The tensile strength is the maximum load per unit area which a material is capable of withstanding. It is computed from the maximum load carried during a tension test and the original cross-sectional area of the specimen.

PERCENTAGE ELONGATION

The percentage elongation is the difference in the gage length before being subjected to any stress and after rupture, expressed as a percentage of the original gage length.

PERCENTAGE REDUCTION OF AREA

The percentage reduction of area is the difference between the original cross-sectional area and the least cross-sectional area after rupture, expressed as a percentage of the original cross-sectional area.

In considering the determination of those values for which a method has been suggested that involves the plotting of a stress-strain curve, there are several factors that should be borne in mind.

The machine used must be sensitive to small load changes and be very accurate. The instrument used for measuring elongation or strain must be of sufficient sensitivity so that reactions to small loads can be recognized readily and accurately.

Whenever any method is applied involving the use of an extensometer it is well to apply a small initial load, usually 5000 pounds per square inch, before taking the readings. This will take up any looseness or play in the equipment and set-up, and give more consistent results and a clearer modulus line.

With some specimens, particularly from as-rolled or cold-worked material, it will be found that the stress-strain curve exhibits a slight curvature over practically the entire elastic range, or a departure from the straight line relationship within the elastic range. This is evidence of unrelieved strains which should be removed by a stress-relieving treatment on the part from which the tests are taken if determinations of accurate elastic values are attempted. Generally speaking the determination of elastic properties with the use of the extensometer is more applicable to heat-treated material than to as-rolled, cold-worked, or untreated products.

Regardless of the method used in tension testing or the degree of sensitivity of the testing equipment, the personal element cannot be overlooked. Accurate results require well-trained and experienced operators.

WORKING OF STEEL

HEATING STEEL

LIQUID HEATING BATHS

COLOR CHARTS

QUENCHING MEDIA

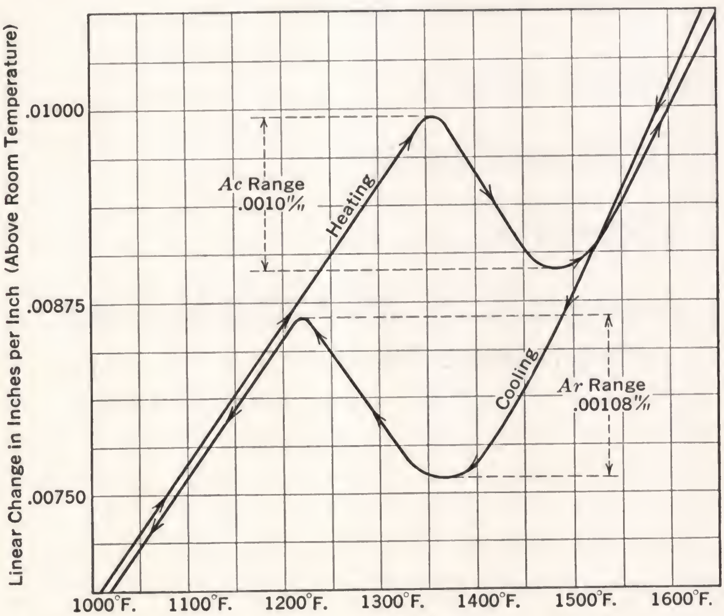
PYROMETERS

ESTIMATION OF UPPER CRITICAL POINT FROM ANALYSIS

HEATING STEEL

IN THE process of heating steel, various dangers are encountered which must be avoided. In addition to cracking, which generally is given the first thought, we also have overheating or burning and excessive decarburization to consider.

Heating steel causes it to expand at an almost constant rate until its critical temperature range is reached. This is known as the coefficient of linear expansion of the steel. Upon reaching the critical or Ac range, the steel ceases to expand and begins to contract, despite the fact that the temperature is still rising. Eventu-

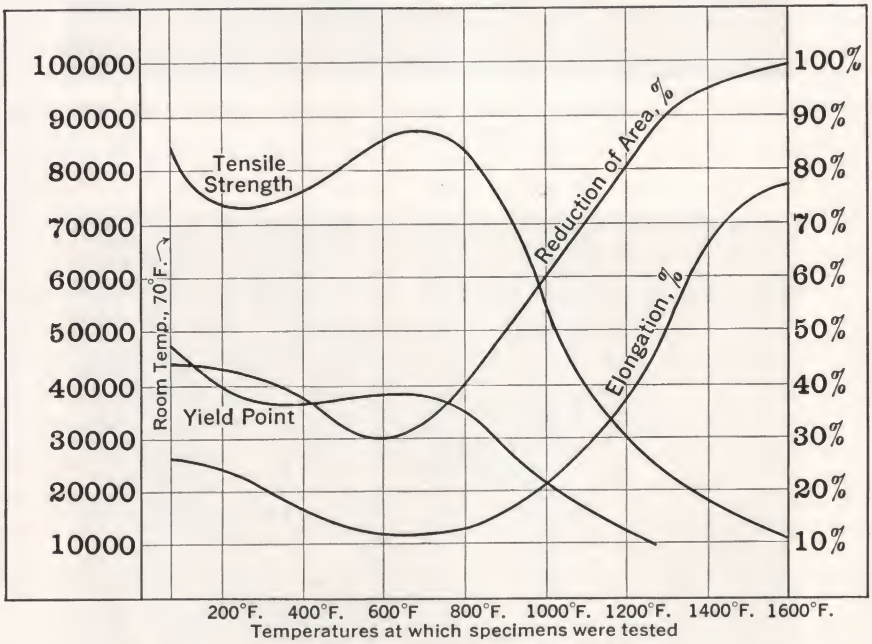


Dilatometer curves of S.A.E. 1045 Steel normalized and annealed
When heating at 400 degrees F. per hour and cooling at 440 degrees F. per hour

ally the transformation is completed and expansion is resumed. On cooling, these volume changes are reversed and the critical temperature range of transformation now occurs at a lower temperature.

It must be remembered that steel at elevated temperature does not possess its normal strength. The strength of steel on being heated changes continually, up to the plastic state. As shown on

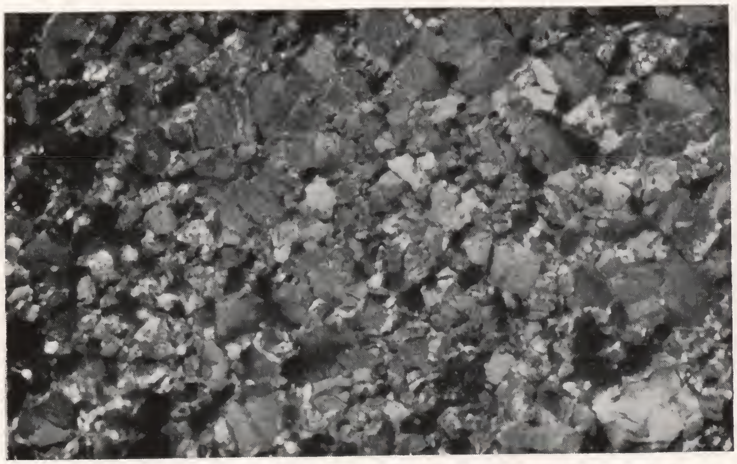
the curve, as the temperature increases above normal, the strength decreases until about 600° to 800° F. is reached, where the "blue brittle range" occurs. At this point the strength increases, often going as high as the strength at normal temperature, and ductility decreases. As the temperature increases beyond the "blue brittle range" the strength rapidly decreases. At 1600° F. steel will show 10,000 to 20,000 pounds per square inch tensile strength, in the grades of steel covered by this publication.



Physical properties of 1 inch round "as-rolled" S.A.E. 1045 Steel at elevated temperatures

A common source of trouble when heating steel is cracking. Cracks are caused by heating or cooling too rapidly or not uniformly and are the result of non-uniform volume changes in the steel, which set up stresses higher than the strength of the part. Steel becomes increasingly more prone to this type of trouble as the percentage of hardening elements increases.

The iron-carbon diagram shows the increasing danger of over-



Photograph of fracture of overheated S.A.E. 1045 steel in hardened condition
Enlarged 3 times

Micrograph of same steel at 100 diameters. Etched with Nital showing grain growth and precipitation around crystals

heating steel as the carbon content increases. Not only must the average temperature of the heating furnace be regulated, but local overheating, such as is caused by direct impingement of the flame against a piece of steel, must be avoided.

The degree of overheating of steel depends on the temperature, atmosphere, and the time the part was kept above the safe heating range. The surface of burnt steel often contains a network of fine cracks. When the abuse was not severe enough to cause burning but when overheating occurred, it is necessary to use the microscope to determine how badly the structure has been broken down.

Overheating has a marked effect on the physical properties of steel, the degree of deterioration, of course, depending on the amount of abuse; until finally, in the case of badly burnt steel, there is little strength, and the piece will practically fall apart.

Decarburization occurs when a piece of steel is heated to any temperature above the scaling point in the usual commercial heating furnace. It takes place, but to a lesser degree, under the so-called reducing atmospheric conditions when a smoky flame is used. To eliminate decarburization requires expensive and rather elaborate equipment for the usual commercial heating furnace.

The degree of decarburization is a function of both temperature and time. It is caused by the carbon in the skin of the hot steel, chemically uniting with oxygen. Carbon in hot steel migrates, that from the layer of steel under the skin passing to the lower-carbon or carbon-free skin. This action is progressive so long as the steel is kept under the conditions which cause decarburization, and continually increases the depth of the lower-carbon case.

In a low-carbon steel the reaction is not severe because it lacks the carbon content to support the migration. As the carbon content increases, the severity of the reaction likewise increases. It is therefore necessary to exercise more care in heating the higher carbon steels.

Fortunately, in most cases, machining or grinding removes the decarburized surface and prevents deleterious effects on parts where hard surfaces are necessary for wear or abrasion.

LIQUID HEATING BATHS

IMMERSION heating has many distinct advantages which make it desirable for routine hardening and tempering operations. It makes possible rapid and uniform heating of parts, prevents scale, thus eliminating subsequent cleaning operations, and helps to prevent warping or cracking of intricate sections.

Three types of heating baths are in common use and may be classified as follows:

	Temperature Range		
No. 1—Oil	Up	to	600 degrees F.
No. 2—Lead	650	to	1600 degrees F.
No. 3—Salts	300	to	2400 degrees F.

Oil baths are used for low temperature drawing operations where it is not necessary to exceed 600 degrees F. As this temperature is approached, increasing difficulty will be encountered in controlling the bath and at the same time a gum or coke deposit is apt to form on the work. This deposit can be removed only by hot caustic or kerosene.

It must be remembered that the use of oil baths at high temperatures involves a fire hazard which can be avoided by replacing the bath with one using low temperature salts.

Lead baths have a high heating rate and although they are used mainly for the drawing of high speed steel, they can be employed for other heating operations up to 1600 degrees F. Since lead oxidizes rapidly, it is necessary to keep the bath well protected by charcoal, molten salts, etc., when working at high temperatures, to prevent the formation of scum or dross, which may cling to the work and retard any subsequent quenching operation.

Salt baths are used for a wide range of temperatures. With the exception of the extremely low temperatures it will usually be found more convenient to either make up or buy ready prepared salts for use within the different hardening or drawing ranges. These baths are easily controlled at the desired temperatures and effectively prevent scaling.

COLOR CHARTS

HEAT COLORS

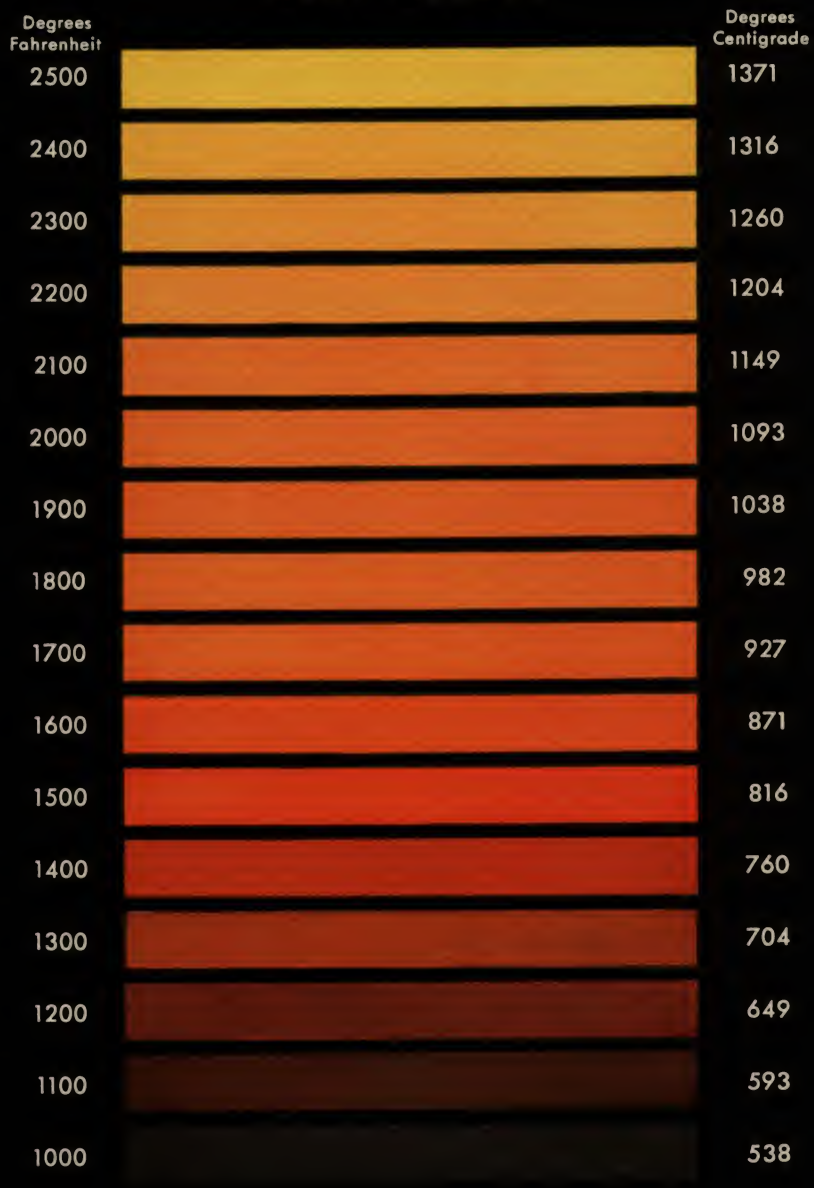
The heat colors on the following page apply to carbon steels just as well as to the 3140 steel from which they were taken. These are reproductions of the colors observed on the steel as seen through peep holes in enclosed furnaces and during average daylight conditions. The colors shown are approximately correct for these conditions. There are, however, many factors which enter into the visual appearance of the heated steel, such as conditions of artificial or natural light, the character of the scale on the steel, the amount of radiated light within the furnace, the emissivity or tendency of steel to radiate or emit light, etc., and all these affect the apparent colors.

It is impossible to register by printed color the brilliance or intensity of the color of the metal, which in practical application is as valuable as the color itself.

TEMPER COLORS

The temper colors shown on page 271 were observed on drawing S. A. E. 1095 steel to the temperatures indicated.

HEAT COLORS



The above heat colors are reproductions of colors observed on pieces of 31-40 steel as seen through peep holes in enclosed furnaces and during average daylight conditions.

TEMPER COLORS

Degrees Fahrenheit	Degrees Centigrade
700	371
660	349
620	327
580	304
540	282
500	260
460	238
420	216
380	193

The above temper colors were observed on drawing 10-95 steel to the temperatures indicated.

QUENCHING MEDIA

QUENCHING media are used to remove heat from the surface of steel to develop certain desired properties in the metal. The properties generally sought are increased hardness and strength, and crystalline refinement. There are several factors to be considered in the selection of quenching media.

Certain grades of steel, on account of the high critical cooling rate necessary for hardening, can be hardened only a moderate depth below the surface. In this class, to which the carbon steels belong, a quenching medium that has a fast cooling rate is required. Additions of alloying elements to steels lower the critical cooling rate and thereby permit the use of quenching media that have a slower cooling rate.

Hardness of steel developed by quenching, distortion, and residual stresses are all functions of the cooling rate of the quenching media during hardening and must be considered when selecting a medium for quenching.

Contrary to the old belief that heat from metal is dissipated by convection, the actual cooling of the metal surface in the early stages of quenching is accomplished by the formation and motion of vapor of the liquid. It is not until the surface of the metal reaches about 500°-600° F. that convection cooling by the quenching liquid begins. It has been found that the quenching medium should be most effective when the steel reaches about 1000°F. Effectiveness of the quenching operation is always improved by rapid circulation of the quenching medium or rapid movement of the cooling part in the medium. This action wipes away the gas bubbles as they are formed in the early stage of the operation, and as the piece cools, it brings the cooler quenching liquid in contact with the piece.

The most common types of quenching media include (1) water and aqueous solution of salts, acids and alkalies, and (2) oils: mineral, vegetable and animal. Comparative quenching rates, with still water at 68°F. as the base unit of comparison, are given by A. S. M. as follows:

Quenching Medium at 68° F.	Relative quenching rate Still	Relative quenching rate 3 ft. per sec.
Water	1.00	1.01
5% Sodium Chloride	1.12	1.14
10% Sodium Chloride	....	1.23
2½% Sodium Hydroxide	1.19	
5% Sodium Hydroxide	1.17	1.20
5% Calcium Chloride	1.06	
10% Calcium Chloride	1.17	
Prepared Oil	0.35 to 0.44	
Mineral Oils		
Transformer Oil	0.17	
Machine Oil	0.22	
Paraffin Oil	0.29	
Fuel Oil	0.36	

Quenching Medium at 68° F.	Relative quenching rate Still
Vegetable Oils	
Palm Oil	0.15
Rapeseed Oil	0.22
Castor Oil	0.29
Cottonseed Oil	0.36
Olive Oil	0.37
Animal Oils	
Lard Oil	0.19
Fish Oil	0.31
Sperm Oil	0.33
Neatsfoot Oil	0.33
Mixed Oils	
Pale Neutral Oil	0.26
Heavy Residuum Oil	0.29
Mixture of the two	0.32 to 0.42

Water is the most convenient of all the quenching media. The quenching rate of water drops with the rise of temperature. Near the boiling point it has less than 10 per cent of the quenching rate at 68°F. This is due to the vapor blanket formed, preventing effective heat dissipation.

Oils produce less distortion and less residual stress in steel, and therefore, are well adapted to complicated shapes and steels difficult to harden without cracking. Vegetable and animal oils are rendered gummy and produce offensive odors by the heat from hot metal. In most localities they are expensive. Mineral oils are generally used for quenching because of their lower cost and more stable nature than vegetable and animal oils.

In selecting an oil, several factors should be considered:

(1) The oil must have the proper cooling rate to produce the desired properties in the steel.

(2) It must be reasonably stable.

(3) It should be generally available and low in initial cost.

(4) It should be chemically inactive with hot metal.

(5) It should have a high flash point.

(6) It should not change cooling rate appreciably with increased temperature.

Sodium chloride solutions reduce the effect of vapor blanket, and are therefore more efficient than water. Ten per cent brine solution is often recommended but higher concentrations are to be avoided. It is always necessary to rinse the metal after quenching in brine solution so as to avoid corrosion.

Sodium Hydroxide solutions give a bright finish to steel after quenching and do not corrode the steel. Only solutions of low concentration are recommended. These solutions will irritate the skin and therefore require care in handling.

Steel after quenching, regardless of the medium used, should be drawn immediately after the quenching operation. There is great danger of cracking as long as the part contains the unrelieved quenching strains. It is recommended that the part be put in the drawing furnace before it has cooled to room temperature, as insurance against trouble of this nature.

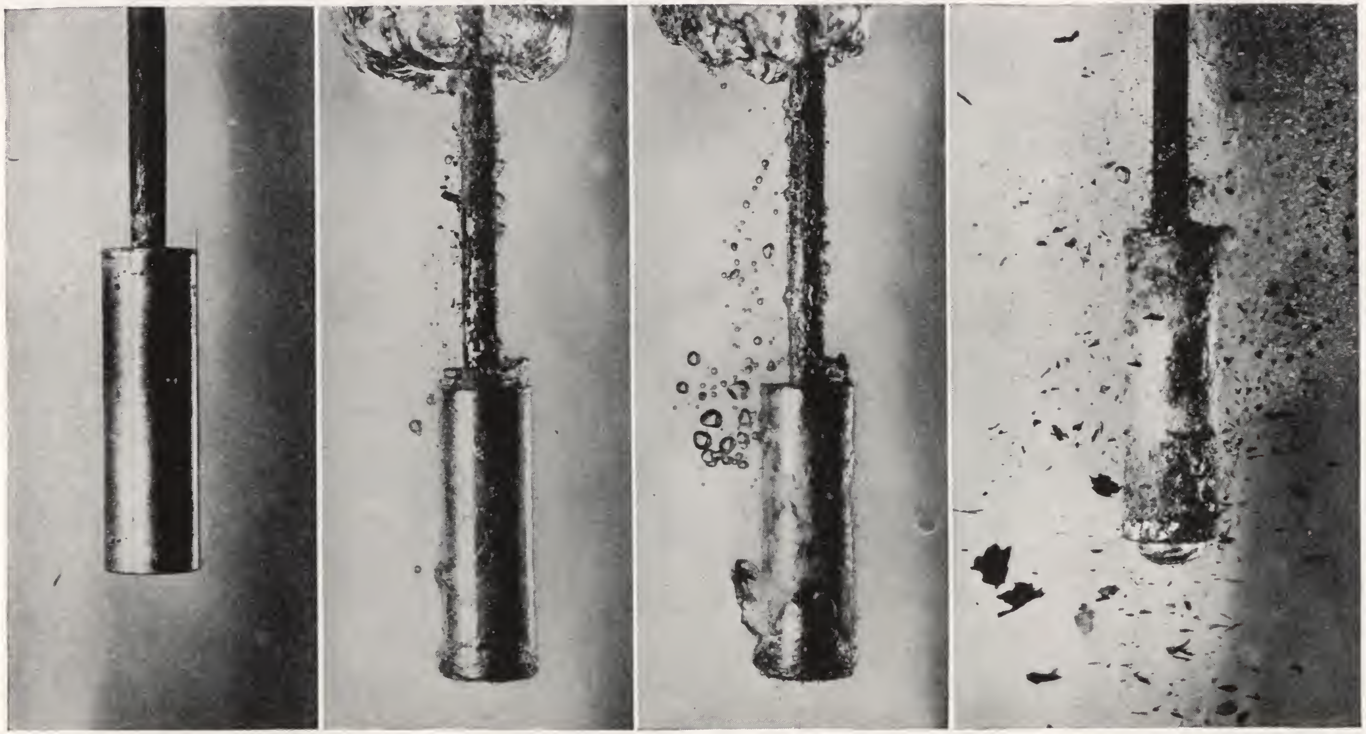
The illustrations on pages 275, 276 and 277 show the reaction which occurs during the quenching operation in different media. They are reproduced by permission of the maker, Professor I. N. Zavarine, Department of Mining and Metallurgy, Massachusetts Institute of Technology, and "Metal Progress," published by the American Society for Metals.

These photographs were made by a method of high speed photography developed by Professors Egerton and Germeshausen at the Massachusetts Institute of Technology. It consists of instantaneous illumination of the object by means of a spark of high intensity, which is produced by a discharge of an electrical condenser between two magnesium electrodes; the duration of the spark is estimated to be one millionth of a second, short enough to stop effectively all motion of the object being photographed.

The procedure in making the pictures was briefly as follows: a specimen 5/8 in. diameter and 2 in. long, supported by a 1/4-in. rod, was heated in a vertical electric furnace located above the quenching bath. Guides were used to insure proper alignment of the specimen in the field covered by the photographic camera.

Briefly summarizing the results obtained, it is concluded that water and oil behave somewhat similar with respect to continuous moving envelopes of steam or oil vapor around the quenched pieces. The greater velocity of the brine or of caustic soda quench, as compared with water quenching, is due principally to the mechanical agitation of the quenching solution induced by the explosion of salt crystals.

BRINE QUENCHING —— WATER QUENCHED CYLINDERS ——



Quenching complete in 5 seconds Shown here for comparison — Start of 1550 degree F. quench — After start of quench — Two seconds after start of quench

Relatively quiet at start with thin film of steam moving in wave-like motion toward the top of specimen and a few steam bubbles given off. Air balloon rising is at top of picture. In two seconds action is violent enough to tear off scale.

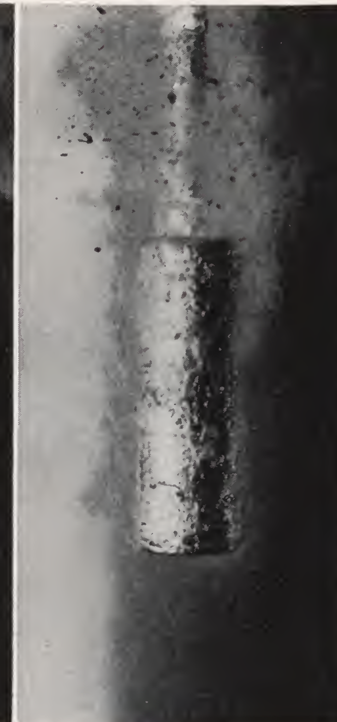
BRINE QUENCHED CYLINDERS

Beginning of quench in 20 per cent solution of sodium chloride

Beginning of quench in 5 per cent solution of sodium chloride

The brine has just touched the hot surface of the specimen and a cloud is instantaneously formed. Fragments of scale are flying away, but there is no question that the main cloud consists of salt crystals which were precipitated on the surface of the metal in the steam envelope.

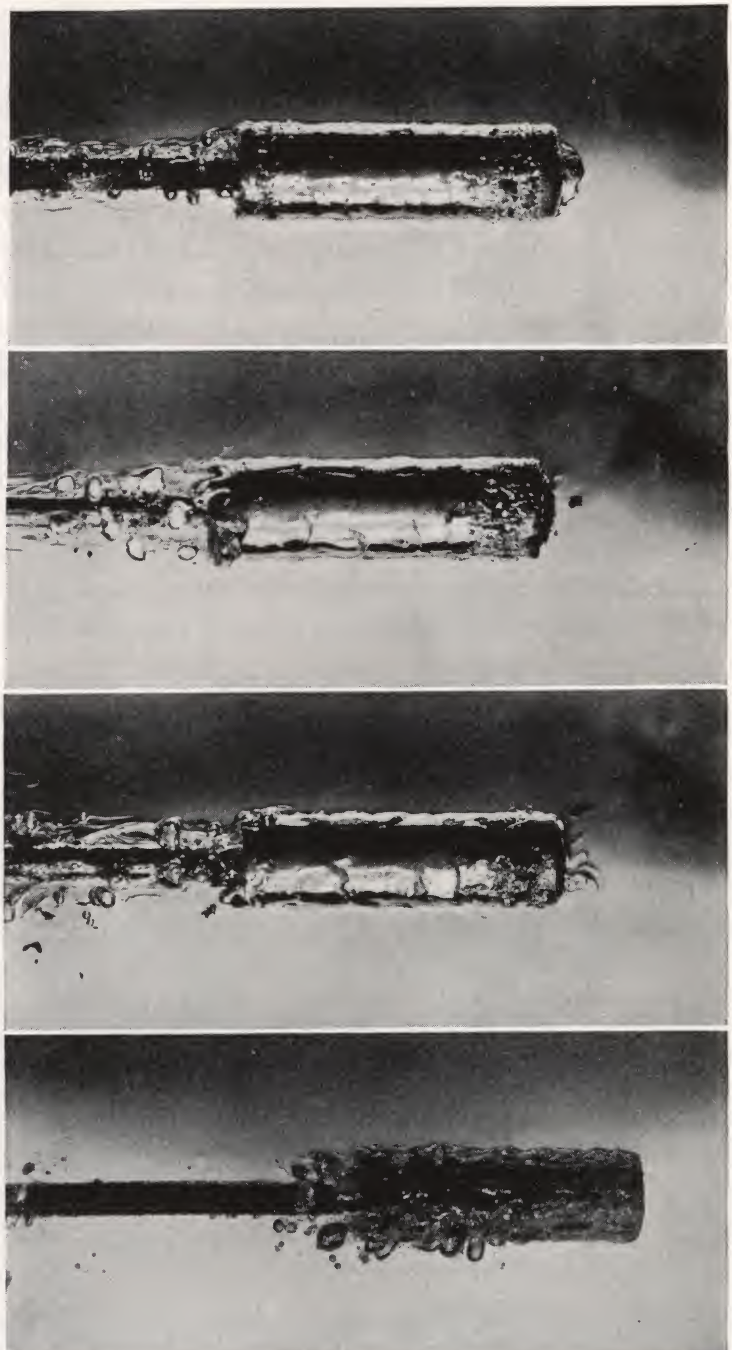
Two-step quench. Specimen retained in a position above the field of the photograph for an instant and then dropped to a lower position



Two-step quench. Specimen retained in the upper position one quarter second and photographed

In a brine or caustic solution the action is quite distinctive. A cloud of salt crystals is thrown away from the hot metal with explosive violence. Finish of quench is shown at extreme left of page **275**.

OIL QUENCHED CYLINDERS



Beginning of quench in transformer oil

One-half second after the beginning of quench in Russian oil

One second after beginning of quench in Russian oil

Five seconds after the beginning of quench in Russian oil

Oil quench acts like water quenching at a more deliberate pace. Bubbles of oil vapor form quickly, and the vapor quickly forms a relatively thin layer with same wave-like motion as water quenching.

PYROMETERS

THE optical pyrometer principle is based on comparing and balancing luminous radiations. Optical pyrometers utilize the method of varying the brilliancy of a standard in comparison with the object until a visual balance is obtained. This type of pyrometer is used for determining temperatures of 1400° F. and higher, in such operations as at the open hearth and electric furnace for both steel and slag; tapping and teeming; soaking pits and heating furnaces; rolling mills and forge shops; tapping and pouring cast iron; and for coke oven flue temperatures, etc.

Radiation pyrometers, of which there are two classes, are virtually reflecting telescopes: those which measure, as heat, the total radiation falling upon the receiving body of the instrument; and those based upon the principle that the intensity of light from incandescent bodies varies in a definite manner as the temperature changes. They are used at rolling mills, heating furnaces, and for refractory temperatures, etc.

Thermocouple pyrometers are of the contact, recording, and automatic control types. The measurement of the electromotive forces developed in a thermocouple is used to indicate temperatures. An increase in temperature results in an increase of electromotive force developed. The thermocouple consists of two parallel electrical conductors of dissimilar metal, joined at one end but otherwise insulated from each other. Materials commonly used for thermocouples are: platinum, platinum-rhodium, iron-constantan, chromel-alumel.

The contact thermocouple pyrometer is used for reading temperatures of steel having no heat color (under approximately 1000° F.). While the temperatures observed may not be the actual temperatures, they are helpful for certain uses as a comparison or guide.

The recording, and automatic control pyrometers are extensively used in heat-treatment shops. All heat-treatment furnace temperatures can be controlled by automatic recorders to assist in obtaining uniformity. Other operations controlled by automatic

recorders are at blast-furnaces, open hearth furnaces, heating furnaces, core drying ovens, etc.

The immersion thermocouple pyrometer has the thermocouple inserted in a suitable protection tube. The thermocouple when immersed in molten metal develops an electromotive force which is recorded as stated above.

The photo-electric tube, often referred to as the electric eye, is a vacuum tube or an inert-gas-filled tube by means of which light can be made to control the flow of electromotive force. In general, its use as a pyrometer is comparable in operation to the radiation pyrometer. The electric eye is also used in the steel industry for such purposes as controlling operating units, starting and stopping motors, operating flying shears, etc.; and for indicating devices, and pyrometers.

In using pyrometers, it must be remembered that any type of instrument records only the temperature of the part at which the apparatus is sighted, or the temperature where the thermocouple is located. Care must therefore be exercised to insure getting representative temperature readings. Pyrometers should be calibrated frequently for the best results.

Experimental heat-treating department (Metallurgical division)

ESTIMATION OF THE UPPER CRITICAL POINT FROM ANALYSIS

A METHOD[1] of estimating the approximate upper critical point (Ac_3) from a known analysis of steel is valuable as a check method or substitute for the dilatometer and other methods.

While this method is only an estimation or approximation, in many cases it is satisfactory, and when the proper scientific equipment is not available, it is a convenient way of determining the upper critical point of steel.

The calculations are based on the following constants:

Upper critical point (Ac_3) for pure iron is 1666.4° F.
Carbon constant = minus 4.027° F. for each 0.01% of carbon
Manganese constant = minus 0.6197° F. for each 0.01% of manganese
Phosphorus constant = plus 0.7893° F. for each 0.001% of phosphorus
Silicon constant = plus 0.5488° F. for each 0.01% of silicon
Nickel constant = minus 0.414° F. for each 0.01% of nickel
or plus 3.6 (C − 54 + 0.06 Ni.) if quantity in bracket is positive
Vanadium constant = plus 0.6826° F. for each 0.01% of vanadium

For example, to determine the upper critical points of S. A. E. 1045 steel using for comparison the upper and lower percentage of the elements permitted for this grade, the calculations are as follows:

S. A. E. 1045 Steel

Contained elements	Carbon	Manganese	Phosphorus	Sulphur	Silicon
Lowest percentage	0.40	0.60	0.025	0.025	0.14
Highest percentage	0.50	0.90	0.045	0.055	0.24

Constant for each of the elements		Critical point of the lower percentage of the elements
Ac_3 for Pure Iron		= 1666.400° F.
Carbon	.40 = 40 × −4.027 =	−161.080
		1505.320
Manganese	.60 = 60 × −0.6197 =	−37.182
		1468.138
Phosphorus	.025 = 25 × +0.7893 =	+19.732
		1487.870
Silicon	.14 = 14 × +0.5488 =	+ 7.683
		1495.553° F.

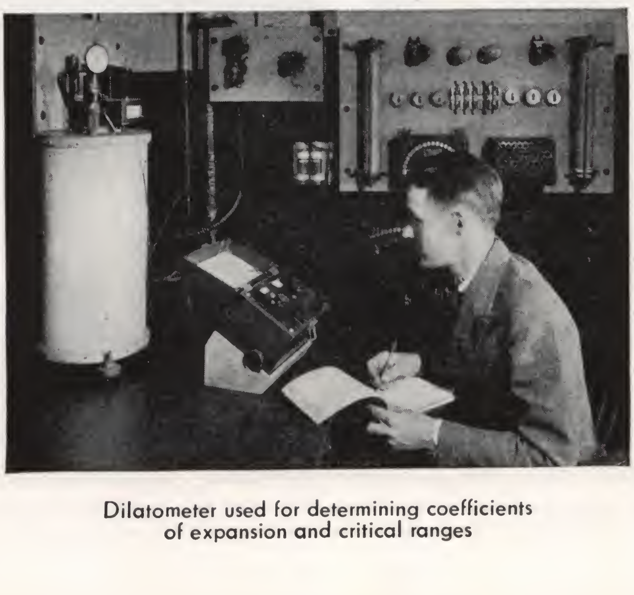
1 By Lt. Col. Robert B. Abbott, Metallurgical Engineer, White Motor Co., 1933.

		Critical point of the higher percentage of the elements
Ac_3 for Pure Iron		1666.400° F.
Carbon	.50 = 50 × —4.027 =	—201.350
		1465.050
Manganese	.90 = 90 × —0.6197 =	—55.773
		1409.277
Phosphorus	.045 = 45 × +0.7893 =	+35.518
		1444.795
Silicon	.24 = 24 × +0.5488 =	+13.171
		1457.966° F.

In using the figures thus obtained, or by scientific apparatus, for determining quenching temperatures for steel, it must be remembered that an allowance must be made for variation in heating, analysis, time from furnace to immersion in quenching media, etc.

This allowance for small parts should be at least 15° F. above the determined critical point. As the size increases the allowance must be greater. No rules can be laid down since consideration must be given each individual case.

In general the best quenching temperature is the lowest temperature that will produce in the steel an effective response. The critical points, no matter how determined, can only be used as a guide for comparison.



Dilatometer used for determining coefficients of expansion and critical ranges

Before steel is made the metallurgical department issues complete instructions regarding open hearth practice, rolling temperatures, and all other processing operations

The operating departments follow these instructions and the metallurgical observer checks, to make complete records, combining the practical and theoretical

PART 3

TABLES
AND
DEFINITIONS

A collection of useful tables and other information, valuable for reference and arranged for general use will be found in the following pages. In part this material has been assembled from a number of sources believed reliable. In part the values have been recalculated or newly calculated to insure a high degree of reliability.

Note: Those interested in the standardization of the value 2.54 cm. for the length of the inch by the American Standards Association on March 13, 1933, and its adoption by more than a dozen countries will understand that the tables, hereinafter, retain the old value of 2.540005080 derived from the American legal standard of 0.3937 inch per cm. This should cause no trouble in five figure computations. Even in six figure computations the last place will not be subject to a change greater than one unit. Only in seven place computations will the last place be subject to a change of more than one unit.

The reason for retaining the old value rests on the important consideration that conversion tables in this book have been recalculated throughout to be fully consistent with the standard values adopted in the International Critical Tables and published in 1926. Furthermore, the Standards authorities have not as yet recalculated and published tables other than those for linear conversions.

Although it is scarcely the province of a handbook of this character to furnish tables for precision work requiring six and seven places of figures, it has been our custom to publish tables accurate to within half of one unit in the last published place. This accuracy could not be retained in the present handbook if we were to revise all tables dependent upon the cm.-inch conversion ratio to the new standard value.

Those having use for the full precision of the tables can easily make the necessary corrections as the number of cm. per inch is reduced almost exactly 2 parts in 1,000,000, or the number of inches per cm. are increased in the same proportion. When derived units contain a power of the conversion ratio, the correction is 4 parts per million for squares, 6 parts per million for cubes or 2n parts per million for the nth power.

The weights of rolled steel are calculated on the basis of 489.6 pounds per cubic foot; and 3.4 times the uniform sectional area in square inches equals the weight in pounds per linear foot.

In all shipments actual weights will govern.

DEFINITIONS OF COMMON TERMS USED IN THE STEEL INDUSTRY

During recent years certain confusion has arisen in regard to the meaning of terms commonly used in the steel industry. For instance, in one locality or trade any operation of heating and cooling which results in a softening of the material is being called annealing, whereas in other places "to anneal" means not primarily "to soften" but to heat above the critical temperature range and cool very slowly. Similar confusion as to meaning and application exists in regard to other terms, and as a result "annealing," "tempering," "normaliz-ing," etc., are being used by different people to mean widely different things.

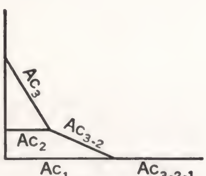


Fig. 1

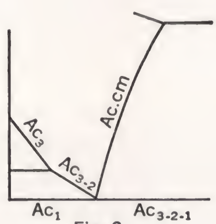


Fig. 2

In any attempt accurately to define the terms commonly used in connection with heat treatment, the first and most important question to decide is: do the terms relate to the heat treatment operation itself, or to the results obtained by the treatment? In other words, is the term indicative of the structure or condition obtained, or of the operation performed?

After careful consideration, it appears most logical and most in keeping with present day usage to have the terms so defined that they shall mean definite operations and shall not be considered as referring to the resultant structure or general conditions.

By "critical temperature range," as used in the definitions, is meant the temperature range illustrated by the diagrams given in Figs. 1 and 2.

Among the following definitions are many which have been taken by permission from the American Society for Metals handbook. There have also been added many new definitions, pertinent to the subject of this book, which are common to the trade, and others relating to both the manufactur-ing and metallurgical branches of the steel industry.

Acid Bottom and Lining—The inner bottom and lining of a melting furnace composed of materials having an acid reaction. The materials may be sand, siliceous rock, or silica bricks.

Acid Brittleness—The brittleness induced in steel, especially wire or sheet, when pickled in dilute acid for the purpose of removing scale. This brittleness is commonly attributed to the absorption of hydrogen.

Acid Steel—Steel melted under a slag which has an acid reaction and in a furnace with an acid bottom and lining.

Aging—The term originally applied to the process or sometimes to the effects of allowing a metal to remain at ordinary temperatures. Heat treatment at temperatures above normal for the purpose of accelerating changes of the type that might take place on aging at ordinary temperature is called "artificial aging," and sometimes merely "aging." When the changes taking place during artificial aging are due to the precipitation of some substance from solid solution the heat treatment may be called "precipitation treatment."

Alloy—A material having metallic properties and consisting of two or more elements, of which at least one is a metal. It is considered by some that the elements must be completely miscible in the liquid state; others apply the term alloy even when liquid miscibility is only partial.

Alloying Elements—Elements added for the purpose of changing properties.

Alpha Iron—See the "Iron-Carbon Diagram" and its application in Part 2.

Amorphous—Non-crystalline.

Annealing—A heating and cooling operation of a material in the solid state, usually implying a relatively slow cooling.

Note—Annealing is a comprehensive term. The purpose of such a heat treatment may be:
(a) To remove stresses.
(b) To induce softness.
(c) To alter ductility, toughness, electrical, magnetic, or other physical properties.
(d) To refine the crystalline structure.
(e) To remove gases.
(f) To produce a definite microstructure.

In annealing, the temperature of the operation and the rate of cooling depend upon the material being heat treated and the purpose of the treatment.

Certain specific heat treatments coming under the comprehensive term "annealing" are:

A. Full Annealing—Heating iron base alloys above the critical temperature range, holding above that range for a proper period of time, followed by slow cooling through the range.

Note—The annealing temperature is generally about 100 degrees Fahr. above the upper limit of the critical temperature range, and the time of holding is usually not less than one hour for each inch of section of the heaviest objects being treated. The objects being treated are ordinarily allowed to cool slowly in the furnace. They may, however, be removed from the furnace, and cooled in some medium that will prolong the time of cooling as compared to unrestricted cooling in the air.

B. Process Annealing—Heating iron base alloys to a temperature below or close to the lower limit of the critical temperature range, followed by cooling as desired.

Note—This heat treatment is commonly applied in the sheet and wire industries and the temperatures generally used are from 1020 to 1200 degrees Fahr.

C. Normalizing—Heating iron base alloys to approximately 100° F. above the critical temperature range, followed by cooling to below that range in still air at ordinary temperature.

Note—Normalizing is rarely practiced with hypereutectoid steels because of the coarsening of the grain and the tendency to crystallize cementite at grain boundaries or in needles. However, it may sometimes be necessary to normalize these steels by heating them above the Ac_{cm} line of the iron-carbon diagram shown in Fig. 2.

D. Patenting—Heating iron base alloys above the critical temperature range, followed by cooling to below that range in air or in molten lead which is maintained at a temperature of about 700 degrees Fahr.

Note—This treatment is usually applied in the wire industry as a finishing treatment or, especially, in the case of eutectoid steel, as a treatment previous to further wire drawing. Its purpose is to produce a sorbitic structure.

E. Spheroidizing—Prolonged heating of iron base alloys at a temperature, in the neighborhood of, but generally slightly below, the critical temperature range, usually followed by relatively slow cooling.

Note—(a) In the case of small objects of high-carbon steels, the spheroidizing result is achieved more rapidly by prolonged heating to temperatures alternately within and slightly below the critical temperature range.

(b) The object of this heat treatment is to produce a globular condition of the carbide.

F. Tempering (also termed Drawing) — Reheating iron base alloys, after hardening, to some temperature below the critical temperature range, followed by any desired rate of cooling.

Note—(a) Although the terms "tempering" and "drawing" are practically synonymous as used in commercial practice, the term "tempering" is preferred.

(b) Tempering, meaning the operation of hardening followed by reheating, is a usage which is illogical and confusing in the present state of the art of heat treating and should be discouraged.

G. Malleableizing—Malleableizing is a type of annealing operation with slow cooling whereby the combined carbon in white cast iron is partially or wholly transformed to temper carbon and in some cases the carbon is entirely removed from the iron.

Note—Temper carbon is free carbon in the form of rounded nodules made up of an aggregate of minute crystals.

H. Graphitizing—Graphitizing is a type of annealing for gray cast iron whereby some or all of the combined carbon is transformed to free or uncombined carbon.

Austenite—See the "Iron-Carbon Diagram" and its application in Part 2.

Banded Structure—A segregated structure of parallel bands which run in the direction of working.

Bark—The decarburized skin or layer just beneath the scale.

Bars—Rounds, Squares, Flats, Hexagons, Octagons, Ovals, Half Ovals, Half Rounds, Special Sections and small shapes are classified as bars. Angles, Channels, Tees or Zees are "bar" size when their greatest dimension is under 3″. Flats are classified as bars when they are 6″ or under in width and 0.250″ or over in thickness.

Bar Mill—A mill consisting of one or more stands of rolls for reducing blooms, billets, or piled muck bars (iron) to bars.

Basic Bottom and Lining—The inner lining and bottom of a melting furnace composed of materials having a basic reaction. The materials may be crushed burnt dolomite, magnesite, magnesite bricks, or basic slag.

Basic Steel—Steel melted under a slag having a basic reaction and in a furnace with a basic bottom and lining.

Bessemer Process—A process for making steel by blowing air through molten pig iron contained in a suitable vessel, thus removing the impurities by oxidation.

Beta Iron—See the "Iron-Carbon Diagram" and its application in Part 2.

Billet—An ingot or bloom that has been reduced through rolling or hammering to an approximate square ranging from 1½″ square to 6″ square, or to an approximate rectangular cross-section of equivalent area. Billets are classified as semi-finished products for re-rolling or forging.

Billet Mill—A mill for rolling ingots and blooms to rectangular or square billets.

Binary Alloy—An alloy containing two principal elements.

Black Annealing—The annealing of tin mill black plate following the initial rolling for relieving the plate of hardness imparted to it while undergoing reduction. Usually done in boxes, sealed to avoid infiltration of air. Called "Black Annealing" since the plates are black at their first annealing, following the hot rolling. In the case of plates for tinning, the second annealing they receive, following the cold rolling, is called "white-annealing."

Blast Furnace—A shaft furnace supplied with air blast, usually pre-heated, for producing pig iron by reducing iron ore. The furnace is continuous in operation; the raw materials (iron ore, coke, and limestone) being charged at the top, and the molten pig iron and slag collected at the bottom and tapped out at intervals; the iron and slag separate because of different specific gravities and are tapped out separately.

Blister—A defect in metal produced by gas bubbles either on the surface or formed beneath the surface while the metal is hot or plastic. Very fine blisters are called pinhead or pepper blisters.

Blister Bar—Wrought iron bars impregnated with carbon and used in the manufacture of crucible steel. Also called blister steel.

Bloom—The product obtained by reducing an ingot to a size greater than 6″x6″ or equivalent cross-sectional area where width is less than twice the thickness. Blooms are classified as semi-finished products.

Blooming Mill—A mill that rolls ingots usually to blooms, billets and slabs. Sometimes called a "Cogging Mill," and when so called in United States, refers to a mill producing shaped blooms used as blanks for subsequent rolling of I-beams, channels, etc.

Blowhole—A hole produced during the solidification of metal by evolved gas which, in failing to escape, is held in little pockets.

Blue Annealing—A process of annealing sheets and light plates; following the rolling or reducing process, by continuous passage on a mechanical conveyor through a long furnace; normally in single layer, not in packs as in box annealing. The sheets when cold have a bluish-black appearance.

Blue Brittleness—Brittleness occurring in steel when in the temperature range of 400 to 700 degrees Fahr., or when cold after being worked within this temperature range.

Box Annealing—Softening steel by heating it in a suitable closed metal box or pot to protect it from oxidation; also called closed annealing or pot annealing.

Brand—The mark put on a product to indicate certain conditions pertaining to its manufacture and in some instances the date of manufacture, and the maker. The brand may be either hand marked, as by stamping, or done in the rolling by having letters or symbols cut in the rolls.

Bright Annealed Wire—Wire carefully annealed in closed pots, usually with reducing gases, to keep surface oxidation to a minimum.

Burning—The heating of a metal to temperatures sufficiently close to the melting point to cause permanent injury. Such injury may be caused by the melting of the more fusible constituents, by the penetration of gases such as oxygen into the metal with consequent reactions, or perhaps by the segregation of elements already present in the metal.

Butt-Weld—The welding of two abutting edges. Used in the manufacture of steel pipe; the pipe so made being called "Butt-Weld Pipe."

Camber—The arch or curvature occurring in bars during rolling, caused by irregularities in elongation, also by uneven contraction while cooling. In flanged sections like I-beams the camber is in the plane of the web, and requires straightening machines to remove it. In sections that have unequal flanges, like rails, the curvature or camber is purposely applied while hot to counteract uneven contraction in order that they will be straight, or nearly so, when cool.

Carbon Free—Metals and alloys which are practically free from carbon.

Carbon Steel—See page 150.

Carbonization—Coking or driving off the volatile matter from fuels such as coal and wood. (Carbonizing should not be confused with "carburizing" q.v.)

Carburizing (Cementation)—Adding carbon to iron base alloys by heating the metal below its melting point in contact with carbonaceous solids, liquids or gases.

Note—The term "carbonizing" used in this sense is incorrect and its use should be discouraged.

Case—That portion of a carburized, nitrided, or cyanided iron base alloy article in which the carbon or nitrogen content has been substantially increased.

Note—Also refers to both case hardening and carburizing.

Case Hardening—Carburizing, and subsequently hardening by suitable heat treatment, all or part of the surface portions of a piece of iron base alloy.

Cast Steel—Any object made by pouring molten steel into moulds.

Casting Strains—Internal stresses set up in metal during transition from the molten state to the solid.

Note—Castings are benefited by being annealed to relieve these stresses, especially if intricate in shape and of large size.

Cementite—See the "Iron-Carbon Diagram" and its application in Part 2.

Chill Cast Pig—Pig iron cast into metal moulds or chills. If a machine is used the product is known as machine cast pig.

Chipping—The cutting of seams and other surface defects from partially worked material so that the defects will not be worked into the finished product; the term applied to the removal of fins and surplus metal from castings and rolled products.

Cleavage Plane—Crystals possess the property of breaking more readily in one or more directions than in others. The planes of easy rupture are called cleavage planes.

Cogging—Rolling or forging ingots to reduce them to blooms.

Cogging Hammer—A forging hammer used to reduce ingots to blooms.

Cogging Mill—See *blooming mill.*

Cold Drawing—The permanent deformation of metal below its recrystallization temperature, by drawing the bar through one or more dies.

Cold Rolling—The permanent deformation of metal below its recrystallization temperature by rolling. This process is frequently applied in finishing rounds, sheets, strip and tin plate.

Cold Shut—(1) A portion of the surface of a metal product which is not integral with the main mass. This usually results from rolling or forging into the product a separate or partially separate piece of metal, such as that which spatters on the surface of an ingot, or mechanical projections. (2) The freezing over of the top surface of an ingot before the mould has been filled, due to an interruption of the stream of metal.

Cold Working—Permanent deformation of a metal below its recrystallization temperature.

Combined Carbon—All of the carbon in iron or steel which is not in the form of graphite.

Continuous Mill—A succession of roll stands, usually in single line formation. The reductions and speeds of rolls in the various stands are progressively related so the bar, strip, etc., can be in engagement with all stands of rolls at the same time.

Core—That portion of a carburized iron base alloy article in which the carbon content has not been substantially increased.

Note—Also refers to both case hardening and carburizing. The word core is sometimes used to indicate the inner part of a billet or bar rolled from rimmed steel to differentiate it from the rimmed portion or rim.

Also a body of sand or other material placed in a mould to produce a cavity in a casting.

Core Structure—A structure having its interior or core of different structure or material from the exterior.

Critical Points—See the "Iron-Carbon Diagram" and its application in Part 2.

Critical Range—See *critical points.*

Critical Temperature—See *critical points*.

Crop—The end or ends of a rolled or forged product containing the pipe or other defects which are cut off and discarded; also termed "crop end" and "discard." Cropping is also the squaring up of irregular ends for the benefit of any further processing.

Cup Fracture—The form of fracture of a tensile test specimen when the exterior portion is extended and the interior relatively depressed, so that it looks like a cup, as the name implies. When only a portion of the exterior is extended the terms "half cupped" and "quarter cupped" are used, as the case may be.

Cupping—A defect in wire which causes it to break with a cup fracture.

Cyaniding—Surface hardening of an iron base alloy article or portion of it by heating at a suitable temperature in contact with a cyanide salt, followed by quenching.

Decalescence—The absorption of heat which occurs when steel is heated through the Ac_1 point.

Decarburization—The removal of carbon (usually refers to the surface of solid steel).

Dendrite—A crystal formed during solidification having many branches and a tree-like pattern; also termed "pine tree" and "fir tree" crystals.

Deseamer—A power driven machine tool having a cutter, hand controlled, for the removal of seams and other surface defects on blooms, billets and slabs.

Die—A solid or split block of hard iron, steel or other material used for cold drawing, also a set of metal blocks used for blanking, coining or forging various shapes.

Differential Heating—Heating conducted in such a way that various portions of an object attain different temperatures so that upon cooling different properties are produced.

Discard—See *crop*.

Dissolved Carbon—Carbon in solution in either the liquid or solid state.

Drawing Back—See *tempering*, under *annealing*.

Edges—See pages 70 and 71.

Elastic Limit—See Tension Test Terms, Part 2, Page 258.

Elongation—See Tension Test Terms, Part 2, Page 261.

Endurance Limit—The maximum stress to which material may be subjected an indefinitely large number of times without causing failure.

Equilibrium—See the "Iron-Carbon Diagram" and its application in Part 2.

Eutectic—An alloy having the lowest melting point possible with the given components.

Eutectoid Steel—See the "Iron-Carbon Diagram" and its application in Part 2.

Exfoliation—The spalling or flaking off of the outer layer of an object.

Fatigue—See comments under Spring Steels and Endurance strength of steels in Part 2.

Ferrite—See the "Iron-Carbon Diagram" and its application in Part 2.

Ferrite Ghost—A faint band of ferrite.

Ferro Alloys—An alloy of iron with an amount of some other element or elements, such as manganese, chromium, or vanadium, used as a means of introducing these elements into steel.

Fiber—A characteristic of wrought metal manifested by a fibrous or woody appearance of fractures and indicating directional properties. Fiber is due chiefly to the extension in the direction of working of the constituents of the metal, both metallic and nonmetallic.

Fiber Stress—Local unit stress at a point or line on a section over which stress is not uniform, such as the cross section of a beam under a bending load.

Fin—A small protrusion or overfill on a bar or casting, corresponding with the parting of the rolls or flasks. (See also Flash.)

Final Period (Deoxidation period)—The last stage of making open hearth or electric furnace steel. It occurs within one to two hours of the tapping time. During this period the molten metal is brought to the desired analysis and deoxidized to the degree required in the final steel. In the open hearth the operation is carried out mainly through the judicious use of deoxidizing ferro alloys, and in the electric furnace it is done with the reducing slag and deoxidizing alloys.

Finished Steel—Steel which is ready for use without any further processing, exclusive of machining, cold drawing or heat treatment. Blooms, billets, slabs, sheet bar, and wire rods are semi-finished.

Finishing Temperature—The temperature at which hot mechanical working of metal is completed.

Fir Tree Crystal—See *dendrite.*

Flakes—Platelets or coarse crystalline spots in steel which usually appear as bright spots when the steel is fractured.

Flash—A protrusion or overfill of excess metal in the form of a fin, usually occurring on forgings made in dies and sometimes on semi-finished rolled products. It is the result of excess metal forcing out at the parting of dies and rolls. The excess metal is usually intentional in die forging in order to avoid under-filling; an exact filling being difficult to obtain with regularity.

Forging Strains—Strains resulting from forging or in cooling from the forging temperature.

Four-High Mill—A mill having four horizontal rolls, one over another; the principle of operation being to have the two inner-most rolls work the material passing between them, and the two outer-most rolls backing up the others. The advantages from this arrangement are several; the most important being to make the working rolls small diameter and backing rolls large diameter in order that thin metal can be more readily entered between the working rolls.

Fracture—The irregular surface produced when a piece of metal is ruptured or broken.

Fracture Test—Breaking a piece of metal for the purpose of examining the fractured surface to determine the structure or carbon content of the metal or the presence of internal defects.

Free Ferrite—Ferrite which is structurally separate and distinct.

Full Annealing—See *annealing*.

Fusible Alloys—A group of nonferrous alloys which melt at very low temperatures. They usually consist of bismuth, lead, tin, etc. in various proportions, and iron only as an impurity.

Gamma Iron—A crystal form of iron (face-centered cubic) see the "Iron-Carbon Diagram" and its application in Part 2.

Ghost, Ghost Lines, or Ghost Structure—See *ferrite ghost*.

Grains—Crystals in metals.

Grain Growth—An increase in the grain size of metal.

Granular Pearlite (also globular pearlite and divorced pearlite)—A structure formed from the pearlitic phase by long annealing of steel or at a temperature just below the lower critical point, causing the cementite to spheroidize in a ferrite matrix. Since "pearlite" connotes a lamellar structure, this name is not recommended; the word "spheroidite" has been proposed.

Granulation—The formation of grains immediately upon solidification. The region in which it occurs is known as the granulation range or zone.

Graphitizing—See *annealing*.

Ground Bars—Bars surface finished by grinding.

Guides—Forms placed on either or both sides of a roll stand to insure the proper entry and delivery of the section being rolled.

Guide Marks—Scratches that occur on rolled products caused by irregularities in the guide.

Hair Seam—See *seam*.

Hardening—Heating and quenching certain iron base alloys from a temperature either within or above the critical temperature range. Steel can also be hardened by cold mechanical work.

Heat Tinted Fracture Test—Heating a hardened fractured disc so as to develop contrast between non-metallic inclusion stringers and ferrous constituents on the longitudinal fractured faces.

Heat Tinting—Heating a polished specimen in air after a brief preliminary treatment with dilute acid for the purpose of developing the structure by oxidizing or otherwise affecting the different constituents.

Heat Treatment—An operation, or combination of operations, involving the heating and cooling of a metal or alloy in the solid state for the purpose of obtaining certain desirable conditions or properties.

Note—Heating and cooling for the sole purpose of mechanical working are excluded from the meaning of this definition.

Hot Metal—The name commonly given the product of the blast furnace while in the molten state and intended for use while molten.

Hot Shortness—Brittleness in metal when hot.

Hot Top—See *sinkhead.*

Hot Working—The mechanical working of metal above the recrystallization temperature.

Hypereutectoid Steel—See the "Iron-Carbon Diagram" and its application in Part 2.

Hypo-eutectoid Steel—See the "Iron-Carbon Diagram" and its application in Part 2.

Impact Test—A test in which one or more blows are suddenly applied to a specimen. The results are usually expressed in terms of energy absorbed or number of blows (of a given intensity) required to break the specimen.

Inclusions—Particles of slag and dirt occurring in metal which were mechanically held during solidification.

Ingots—Castings of uniform sizes and shapes for subsequent rolling, forging or processing. A steel ingot is usually cast in a thick walled cast iron mould.

Ingot Iron—An open hearth product very low in carbon, manganese, and other impurities.

Killed Steel (also Dead)—See page 154.

Lap—A surface defect appearing as a seam caused from folding over hot metal, fins, or sharp corners and then rolling or forging, but not welding, them into the surface.

Lap Weld—The welding of two overlapping margins or edges. The skelp used in making lap weld tube and pipe has its margins beveled or scarfed so that when overlapped and welded the wall thickness of the finished tube or pipe is at no one place greater than at another.

Liming—A thin coating of lime applied to steel by dipping it into tanks containing slaked lime emulsion. The lime neutralizes traces of pickling acid, and acts as a lubricant for cold drawing and as protection against corrosion.

Lute—A plastic mixture of a bonding material such as clay, loam, cement, etc., used for sealing openings to prevent leaks of air or gases, and for making gas-tight joints between a vessel and its cover. "Lute" or luting is applied to the operation. Sand is also used for sealing when a tight joint is not necessary.

Macroscopic—Visible either with the naked eye or under low magnifications (up to about 10 diameters).

Macrostructure—The structure and internal condition of metals as revealed on a ground or polished (and sometimes etched) sample, by either the naked eye or under low magnifications (up to about 10 diameters).

Malleableizing—See *annealing.*

Martensite—See the "Iron-Carbon Diagram" and its application in Part 2.

Matrix—The ground mass or principal substance in which a constituent is embedded.

Mechanical Working—Subjecting metal to pressure exerted by rolls, presses, or hammers, to change its form, or to affect the structure and therefore the physical properties.

Melting Period (or Melt down)—First stage (while the charge is being melted) in the making of open hearth or electric furnace steel.

Modulus of Elasticity—The ratio, within the limits of elasticity, of the stress to the corresponding strain. The stress in pounds per square inch is divided by the elongation in fractions of an inch for each inch of the original gage length of the specimen.

Network Structure—A structure in which the grains or crystals of one constituent are partially or entirely surrounded with envelopes of another constituent. The appearance of an etched section through the crystals is that of network.

Neumann Bands—Parallel lines or narrow bands running across crystalline grains of metal. The lines or bands undoubtedly indicate mechanical twins. Neumann bands are generally produced by a sudden deformation of the metal such as would result from shock, impact, or explosion.

Nitriding—Adding nitrogen to iron base alloys by heating the metal in contact with ammonia gas or other suitable nitrogenous material.

Note—Nitriding is conducted at a temperature below the iron-carbon critical temperature range and produces surface hardening of the metal without quenching.

Normalizing—See *annealing.*

Oiling—A coating of oil to prevent steel from corroding.

Overheating—Heating to such high temperatures that the grains have become coarse, thus impairing the properties of the metal.

Patenting—See *annealing.*

Pearlite—See the "Iron-Carbon Diagram" and its application in Part 2.

Permanent Mould—A metal mould which is used repeatedly for the production of many castings of the same form. Name not commonly applied to ingot moulds.

Permanent Set—Permanent deformation.

Phosphorus Banding—A faint band of metal containing phosphide segregations.

Pickling—Removing scale from steel by immersion in a diluted acid bath.

Piercing—Producing a hole in metal by forcing a pointed instrument into it or through it. The piercing, that is, the initial operation in making a seamless tube from a solid steel bar, is a combination of rolling and piercing; the rolls making the round revolve, at the same time forcing it against the point of the piercing bar.

Pig Iron—The name commonly given to the metallic or ferrous product of the blast furnace when it is solidified and divided into blocks convenient for handling.

Pine Tree Crystals—See *dendrite.*

Pinhead Blister—See *blister.*

Pipe—A cavity formed in metal (especially ingots) during the solidification of the last portion of liquid metal. Contraction of the metal causes this cavity or pipe.

Pit—A depression in the surface of metal.

Plates—(Commercial Definition) Flat Rolled Steel. Over 6″ in width and ¼″ (10.2 lb. per sq. ft.) or over in thickness. Over 48″ in width and 3/16″ (7.65 lb. per sq. ft.) or over in thickness. Plates can be defined as being either Sheared Plates or Universal Plates, the name implying the type of mill on which the material is rolled.

Polished Bars—Bars surface finished by polishing.

Pot Annealing—See *box annealing.*

Process Annealing—See *annealing.*

Proof Stress—See Tension Test Terms, Part 2, Page 258.

Proportional Limit—See Tension Test Terms, Part 2, Page 257.

Quaternary Alloy—An alloy containing four principal elements.

Quenching—Rapid cooling by immersion. Immersion may be in liquids, gases, or solids.

Rail Mill—A mill for reducing blooms to rails. Light rails are usually produced from large billets on a lighter mill called a "Light Rail Mill." Sometimes the medium light and lightest rails are rolled on a bar mill.

Recalescence—The liberation of heat when steel is cooling through the Ar_1 point.

Reduction of Area—See Tension Test Terms, Part 2, Page 262.

Red Shortness—Brittleness in steel when it is red hot.

Refining Temperature or Heat—A temperature employed in heat treatment to refine the structure, in particular, the grain size. Usually just above Ac_3 in steel.

Regenerative Quenching—A double quenching of carburized objects to refine the case and core. The first quench is from a high temperature to refine the core and the second quench is from a lower temperature to further refine the core and harden the case.

Reversing Mill—A two high mill in which a bar is passed back and forth between the rolls by reversing the direction of rotation of the rolls.

Rimmed Steel—See page 154.

Rods—Wire rods are semi-finished hot rolled rounds of extreme length, usually coiled, and used principally for drawing to wire.

Rod Mill—A mill for rolling rods from billets.

Roll Marks—Slight impressions or depressions occasionally appearing on rolled products, caused by spalling or other imperfections in roll surfaces; other marks being the scoring that results when collars of the rolls are moving at a speed different than that of the object being rolled—in flanged sections principally.

Scab (Scabby)—A rough projection on a casting caused by the mould breaking or being washed by the molten metal; or occurring where the skin from a blowhole or other defect has partly burned away and is not welded.

Scale—A coating of metallic oxide that forms on hot metal.

Scarfing (Deseaming)—The removal of seams and other surface defects by cutting with the gas torch; also the beveling of skelp with a cutting tool.

Seam—A crack on the surface of metal which has been closed but not welded up; usually produced by blowholes which have become oxidized. If very fine, a seam may be called a hair crack or hair seam; also see cold shut and lap.

Secondary Hardening—Increased hardness developed by tempering high alloy steel in certain temperatue ranges.

Self Hardening Steel—Alloy tool steel that becomes hard enough by cooling in air (sometimes an air blast is employed) and whose cutting edges remain practically intact at temperatures approaching a visible red.

Semi-Finished Steel—Blooms, billets, slabs, sheet bars, rods and other products, for re-rolling or forging.

Semi-Steel—Castings produced by melting, usually in a cupola, about one-third to one-fifth by weight of wrought iron or soft steel scrap with cast iron.

Sheared Plate Mill—A mill having horizontal rolls used for rolling ingots and slabs to plates, all margins of which are irregularly formed and require shearing to produce the finished plate.

Sheets—Cold Rolled. The flat products resulting from cold rolling, after pickling, of sheets previously produced by hot rolling. Made in sizes over 12″ wide in sheet thicknesses and gage weights.

Sheets—Hot Rolled. The flat rolled products resulting from reducing sheet bars on a sheet mill; or slabs, blooms and billets on a continuous strip-sheet mill. Made in thicknesses 0.249 inch or thinner, the width limits depending on the thickness.

Sheet Bar—A flat bar of medium width and thickness rolled from a bloom or slab, but usually direct from the ingot, so named on account of being used for rolling sheets, both usual sheets and sheets for tinning, also the light gage plates produced on the jobbing mill. Sheet bars are classified as semi-finished products.

Sheet Bar Mill—A mill for rolling sheet bars. Some have only one stand of rolls, others having numerous stands; the latter usually are continuous mills.

Sheet Mill—A mill which ordinarily rolls sheet bar to sheets. One type of mill rolls the reduced sheet bar in packs consisting of several layers. Another type consists of a number of stands for continuous rolling in a long single band.

Shortness—Brittleness in metal.

Silky Fracture—A steel fracture having a very smooth, fine grain, or silky appearance.

Sinkhead or Hot Top—A heat-insulated reservoir for additional metal on top of an ingot mould to fill up the shrinkage space of the ingot proper that occurs during solidification.

Skelp—Flat bars or plates of steel or wrought iron from which pipe and tubes are made.

Skelp Mill—A mill for rolling skelp. There are several kinds since pipe and tube produced by butt weld and lap weld processes range from $\frac{1}{4}''$ diameter to 30″ diameter; the range of width being approximately $1\frac{1}{4}''$ to $97\frac{1}{2}''$. Bar mills roll the narrow and intermediate widths, and plate mills roll from the intermediate to the maximum widths.

Slab—An ingot reduced, generally by rolling, to a thickness better suited to the operation that follows. A slab as distinguished from a bloom, has width at least twice its thickness, and a minimum thickness of $1\frac{1}{2}''$. It is re-rolled to plates and to sheet bar. Sometimes it is the finished product used for column bases, and extremely thick plate, etc. Slabs are classified as semi-finished products.

Slabbing Mill—A mill having horizontal and vertical rolls, used to reduce ingots to slabs. The horizontal rolls control thickness and the vertical rolls control width of the slab.

Slip Bands—A series of parallel lines running across a crystalline grain. Slip bands are formed when the elastic limit is passed by one layer or portion of the crystal slipping over another portion along a plane, known as the slip plane.

Slip Plane—See *slip bands*.

Soaking—Holding steel at a fixed temperature in a heating furnace for a sufficient time to allow complete and uniform penetration of the heat.

Solidification Range—The temperature range through which metal freezes or solidifies.

Solidus—The lower line of a fusibility curve, below which the metal is entirely solid.

Sonims—Solid nonmetallic oxidized inclusions in metal.

Sorbite—See the "Iron-Carbon Diagram" and its application in Part 2.

Spalling—The cracking and flaking of small particles of metal from the surface.

Spheroidizing—See *annealing*.

Spiegel (also Spiegeleisen)—A pig iron containing 15 to 30 per cent manganese and 4.5 to 5.5 per cent carbon.

Stead's Brittleness—A condition in which the grains of a steel with less than about 0.15 per cent carbon, when heated for a very long time (hours or days) between 930 and 1380 degrees Fahr., are greatly increased in size and the metal becomes brittle.

Strip—Cold Rolled. The flat products resulting from cold rolling, after pickling, of strip previously produced by hot rolling. Made in cut lengths in sizes 12 inches or narrower in strip gage weights and thicknesses; also in coils in sizes under 24 inches wide in strip gage weights and thicknesses.

Strip—Hot Rolled. The flat products resulting from reducing sheet bars by hot rolling on a sheet mill; or slabs, blooms and billets on a continuous strip mill. Made in widths under 24 inches, in thicknesses between 0.249 and 0.025 inch, the width depending on the thickness.

STRIP MILL—A mill for rolling slabs, blooms and billets to strip thicknesses. Commonly a continuous mill with rolls revolving at high speed in order to finish the rolling at sufficiently high temperature.

STRUCTURAL MILL—A mill for rolling blanks, blooms and billets to various structural and miscellaneous shapes that are too large to produce on bar mills.

SWEEP—The sideways curvature in a bar, band and plate due to uneven contraction while cooling.

TAPPING—Removing molten metal from a melting furnace by opening the tap hole and allowing the metal to run out into moulds or into a ladle.

TEEMING—Pouring molten steel from the ladle into moulds.

TEMPERING—See *annealing.*

TEMPER CARBON—A form of graphite in iron base alloys produced by heating below the melting point.

TENSILE STRENGTH—See Tension Test Terms, Part 2, Page 261.

TERNARY ALLOY—An alloy containing three principal elements.

THREE-HIGH MILL—A mill having three horizontal rolls, one above another. The rolls are driven constantly in their selected direction, which enables the piece being rolled to go in one direction through passes in the bottom and middle rolls and return through passes in the middle and top rolls. A three-high mill performs the same service as a two-high reversing mill.

TIN MILL—A mill for rolling tin mill black plate, most of which is to be tinned—hence the names "Tin Mill" and "Tin Plate." Ordinarily a mill using sheet bar. The reduced sheet bar is folded over to make a number of layers known as a "pack" for the final rolling operation. Another type of tin mill consists of a number of stands for continuous rolling in a long single strip while cold.

TOLERANCES—Slight deviations in dimensions or weights or both, allowable in the various products.

TROOSTITE—See the "Iron-Carbon Diagram" and its application in Part 2.

TWIN CRYSTALS—Crystalline grains or parts of grains, which are symmetrical structurally with respect to a plane between them called the twinning plane. Usually if either part of the twin were revolved a certain amount about an axis perpendicular to the twinning plane, the two parts would possess the same orientation.

TWIST—The slight spiral turn that sometimes occurs in a rolled bar, originating either in the rolls or on the cooling bed.

TWISTING GUIDE—A guide placed between mill stands, designed to twist a bar after leaving the rolls of one stand and before entering the rolls of the next succeeding stand; being the means of edging the bloom or billet mechanically. Used mainly on continuous mills on which roll stands are close together, and practically confined to plain sections such as blooms and billets.

TWO-HIGH MILL—A mill having two horizontal rolls. Except in the case of the two-high reversing mill where the bar is passed back and forth between the rolls, also the two-high single direction mill where material being rolled is returned idle over the top roll, the two-high mill is ordinarily the finishing stand of a train of stands in which are rolled rails, structural shapes, bars, etc.

Universal Plate Mill—A mill having horizontal and vertical rolls; the horizontal rolls controlling thickness and the vertical rolls controlling width, in rolling plates from ingots and slabs. The plates from this mill have edges well defined, and do not require trimming.

Wheel Mill—A specially constructed mill for rolling wheels from blanks; the blanks being either sections of a round bar or sections that have been preformed by pressing operations.

White Annealing—See Black Annealing.

Wide Flange Structural Mill—A mill consisting of a main stand and supplementary stand, in close relation, the main stand having two horizontal rolls and two vertical rolls with their respective axes in the same plane and the supplementary stand having only two horizontal rolls. Used to roll I-shaped blanks to I-beams and H sections. The four rolls of the main stand reduce the web and flanges, while the rolls of the supplementary stand "edge" the flanges.

Widmanstatten Structure—When the austenite in low-carbon steel transforms to ferrite and pearlite in such a manner as to produce marked precipitation of the ferrite at the crystallographic planes so that the ferrite appears as long continuous plates which occur in definite directions in each grain, the structure is referred to as the Widmanstatten structure. The term is sometimes applied to similar structures in other alloys.

Wire—The product obtained by drawing rods through a series of dies.

Work Hardness—Hardness developed in metal resulting from mechanical working, particularly cold working.

Working Period (Refining period)—The second stage in making open hearth or electric furnace steel, occurring after the charge has been melted. During this period the molten metal is refined or worked by the action of the slag, additions of ore, limestone, etc., so that the metal is brought toward the final desired chemical composition through the elimination of carbon, phosphorus, sulphur and silicon, except in the acid furnace when phosphorus and sulphur are not eliminated.

Yield Point—See Tension Test Terms, Part 2, Page 260.

Yield Strength—See Tension Test Terms, Part 2, Page 259.

Young's Modulus—See *modulus of elasticity*.

$\frac{1}{16}$—$1\frac{31}{32}$

WEIGHTS AND AREAS OF SQUARE AND ROUND BARS

Size or Diameter Inches	Weight, Lbs. per Ft.		Area, Sq. In.	
	Square	Round	Square	Round
1/16	.013	.010	.0039	.0031
5/64	.021	.016	.0061	.0048
3/32	.030	.023	.0088	.0069
7/64	.041	.032	.0120	.0094
1/8	.053	.042	.0156	.0123
9/64	.067	.053	.0198	.0155
5/32	.083	.065	.0244	.0192
11/64	.100	.079	.0295	.0232
3/16	.120	.094	.0352	.0276
13/64	.140	.110	.0413	.0324
7/32	.163	.128	.0479	.0376
15/64	.187	.147	.0549	.0431
1/4	.212	.167	.0625	.0491
17/64	.240	.188	.0706	.0554
9/32	.269	.211	.0791	.0621
19/64	.300	.235	.0881	.0692
5/16	.332	.261	.0977	.0767
21/64	.366	.288	.1077	.0846
11/32	.402	.316	.1182	.0928
23/64	.439	.345	.1292	.1014
3/8	.478	.376	.1406	.1104
25/64	.519	.407	.1526	.1198
13/32	.561	.441	.1650	.1296
27/64	.605	.475	.1780	.1398
7/16	.651	.511	.1914	.1503
29/64	.698	.548	.2053	.1613
15/32	.747	.587	.2197	.1726
31/64	.798	.627	.2346	.1843
1/2	.850	.668	.2500	.1963
33/64	.904	.710	.2659	.2088
17/32	.960	.754	.2822	.2217
35/64	1.017	.799	.2991	.2349
9/16	1.076	.845	.3164	.2485
37/64	1.136	.893	.3342	.2625
19/32	1.199	.941	.3525	.2769
39/64	1.263	.992	.3713	.2916
5/8	1.328	1.043	.3906	.3068
41/64	1.395	1.096	.4104	.3223
21/32	1.464	1.150	.4307	.3382
43/64	1.535	1.205	.4514	.3545
11/16	1.607	1.262	.4727	.3712
45/64	1.681	1.320	.4944	.3883
23/32	1.756	1.379	.5166	.4057
47/64	1.834	1.440	.5393	.4236
3/4	1.913	1.502	.5625	.4418
49/64	1.993	1.565	.5862	.4604
25/32	2.075	1.630	.6103	.4794
51/64	2.159	1.696	.6350	.4987
13/16	2.245	1.763	.6602	.5185
53/64	2.332	1.831	.6858	.5386
27/32	2.420	1.901	.7119	.5591
55/64	2.511	1.972	.7385	.5800
7/8	2.603	2.044	.7656	.6013
57/64	2.697	2.118	.7932	.6230
29/32	2.792	2.193	.8213	.6450
59/64	2.889	2.270	.8498	.6675
15/16	2.988	2.347	.8789	.6903
61/64	3.089	2.426	.9084	.7135
31/32	3.191	2.506	.9385	.7371
63/64	3.294	2.587	.9689	.7610
1	3.400	2.670	1.0000	.7854
1/32	3.616	2.840	1.0635	.8353
1/16	3.838	3.014	1.1289	.8866
3/32	4.067	3.194	1.1963	.9396
1/8	4.303	3.379	1.2656	.9940
5/32	4.545	3.570	1.3369	1.0500
3/16	4.795	3.766	1.4102	1.1075
7/32	5.050	3.966	1.4853	1.1666
1/4	5.312	4.173	1.5625	1.2272
9/32	5.581	4.384	1.6416	1.2893
5/16	5.857	4.600	1.7227	1.3530
11/32	6.139	4.822	1.8056	1.4182
3/8	6.428	5.049	1.8906	1.4849
13/32	6.724	5.281	1.9775	1.5532
7/16	7.026	5.518	2.0664	1.6230
15/32	7.334	5.761	2.1572	1.6943
1/2	7.650	6.008	2.2500	1.7671
17/32	7.972	6.261	2.3447	1.8415
9/16	8.301	6.520	2.4414	1.9175
19/32	8.636	6.783	2.5400	1.9949
5/8	8.978	7.051	2.6406	2.0739
21/32	9.327	7.325	2.7431	2.1545
11/16	9.682	7.604	2.8477	2.2365
23/32	10.044	7.889	2.9541	2.3202
3/4	10.413	8.178	3.0625	2.4053
25/32	10.788	8.473	3.1728	2.4920
13/16	11.170	8.773	3.2852	2.5802
27/32	11.558	9.078	3.3994	2.6699
7/8	11.953	9.388	3.5156	2.7612
29/32	12.355	9.704	3.6337	2.8540
15/16	12.763	10.024	3.7539	2.9483
31/32	13.178	10.350	3.8760	3.0442

$2—7\frac{15}{16}$

WEIGHTS AND AREAS OF SQUARE AND ROUND BARS

Size or Diameter Inches	Weight, Lbs. per Ft.		Area, Sq. In.		Size or Diameter Inches	Weight, Lbs. per Ft.		Area, Sq. In.	
	Square	Round	Square	Round		Square	Round	Square	Round
2	13.600	10.681	4.0000	3.1416	5	85.000	66.759	25.000	19.635
1/16	14.463	11.359	4.2539	3.3410	1/16	87.138	68.438	25.629	20.129
1/8	15.353	12.058	4.5156	3.5466	1/8	89.303	70.139	26.266	20.629
3/16	16.270	12.778	4.7852	3.7583	3/16	91.495	71.860	26.910	21.135
1/4	17.213	13.519	5.0625	3.9761	1/4	93.713	73.602	27.563	21.648
5/16	18.182	14.280	5.3477	4.2000	5/16	95.957	75.364	28.223	22.166
3/8	19.178	15.062	5.6406	4.4301	3/8	98.228	77.148	28.891	22.691
7/16	20.201	15.866	5.9414	4.6664	7/16	100.53	78.953	29.566	23.221
1/2	21.250	16.690	6.2500	4.9087	1/2	102.85	80.778	30.250	23.758
9/16	22.326	17.535	6.5664	5.1572	9/16	105.20	82.624	30.941	24.301
5/8	23.428	18.400	6.8906	5.4119	5/8	107.58	84.492	31.641	24.850
11/16	24.557	19.287	7.2227	5.6727	11/16	109.98	86.380	32.348	25.406
3/4	25.713	20.195	7.5625	5.9396	3/4	112.41	88.289	33.063	25.967
13/16	26.895	21.123	7.9102	6.2126	13/16	114.87	90.218	33.785	26.535
7/8	28.103	22.072	8.2656	6.4918	7/8	117.35	92.169	34.516	27.109
15/16	29.338	23.042	8.6289	6.7771	15/16	119.86	94.140	35.254	27.688
3	30.600	24.033	9.0000	7.0686	6	122.40	96.133	36.000	28.274
1/16	31.888	25.045	9.3789	7.3662	1/16	124.96	98.146	36.754	28.866
1/8	33.203	26.078	9.7656	7.6699	1/8	127.55	100.18	37.516	29.465
3/16	34.545	27.131	10.160	7.9798	3/16	130.17	102.23	38.285	30.069
1/4	35.913	28.206	10.563	8.2958	1/4	132.81	104.31	39.063	30.680
5/16	37.307	29.301	10.973	8.6179	5/16	135.48	106.41	39.848	31.296
3/8	38.728	30.417	11.391	8.9462	3/8	138.18	108.52	40.641	31.919
7/16	40.176	31.554	11.816	9.2806	7/16	140.90	110.66	41.441	32.548
1/2	41.650	32.712	12.250	9.6211	1/2	143.65	112.82	42.250	33.183
9/16	43.151	33.891	12.691	9.9678	9/16	146.43	115.00	43.066	33.824
5/8	44.678	35.090	13.141	10.321	5/8	149.23	117.20	43.891	34.472
11/16	46.232	36.311	13.598	10.680	11/16	152.06	119.43	44.723	35.125
3/4	47.813	37.552	14.063	11.045	3/4	154.91	121.67	45.563	35.785
13/16	49.420	38.814	14.535	11.416	13/16	157.79	123.93	46.410	36.450
7/8	51.053	40.097	15.016	11.793	7/8	160.70	126.22	47.266	37.122
15/16	52.713	41.401	15.504	12.177	15/16	163.64	128.52	48.129	37.800
4	54.400	42.726	16.000	12.566	7	166.60	130.85	49.000	38.485
1/16	56.113	44.071	16.504	12.962	1/16	169.59	133.19	49.879	39.175
1/8	57.853	45.438	17.016	13.364	1/8	172.60	135.56	50.766	39.871
3/16	59.620	46.825	17.535	13.772	3/16	175.64	137.95	51.660	40.574
1/4	61.413	48.233	18.063	14.186	1/4	178.71	140.36	52.563	41.282
5/16	63.232	49.662	18.598	14.607	5/16	181.81	142.79	53.473	41.997
3/8	65.078	51.112	19.141	15.033	3/8	184.93	145.24	54.391	42.718
7/16	66.951	52.583	19.691	15.466	7/16	188.08	147.71	55.316	43.445
1/2	68.850	54.075	20.250	15.904	1/2	191.25	150.21	56.250	44.179
9/16	70.776	55.587	20.816	16.349	9/16	194.45	152.72	57.191	44.918
5/8	72.728	57.121	21.391	16.800	5/8	197.68	155.26	58.141	45.664
11/16	74.707	58.675	21.973	17.257	11/16	200.93	157.81	59.098	46.415
3/4	76.713	60.250	22.563	17.721	3/4	204.21	160.39	60.063	47.173
13/16	78.745	61.846	23.160	18.190	13/16	207.52	162.99	61.035	47.937
7/8	80.803	63.463	23.766	18.665	7/8	210.85	165.60	62.016	48.707
15/16	82.888	65.100	24.379	19.147	15/16	214.21	168.24	63.004	49.483

WEIGHTS AND AREAS OF SQUARE AND ROUND BARS

Size or Diameter Inches	Weight, Lbs. per Ft. Square	Weight, Lbs. per Ft. Round	Area, Sq. In. Square	Area, Sq. In. Round	Size or Diameter Inches	Weight, Lbs. per Ft. Square	Weight, Lbs. per Ft. Round	Area, Sq. In. Square	Area, Sq. In. Round
8	217.60	170.90	64.000	50.266	11	411.40	323.11	121.00	95.033
1/16	221.01	173.58	65.004	51.054	1/16	416.09	326.79	122.38	96.116
1/8	224.45	176.29	66.016	51.849	1/8	420.80	330.50	123.77	97.206
3/16	227.92	179.01	67.035	52.649	3/16	425.54	334.22	125.16	98.301
1/4	231.41	181.75	68.063	53.456	1/4	430.31	337.97	126.56	99.402
5/16	234.93	184.52	69.098	54.269	5/16	435.11	341.73	127.97	100.51
3/8	238.48	187.30	70.141	55.088	3/8	439.93	345.52	129.39	101.62
7/16	242.05	190.11	71.191	55.914	7/16	444.78	349.33	130.82	102.74
1/2	245.65	192.93	72.250	56.745	1/2	449.65	353.15	132.25	103.87
9/16	249.28	195.78	73.316	57.583	9/16	454.55	357.00	133.69	105.00
5/8	252.93	198.65	74.391	58.426	5/8	459.48	360.87	135.14	106.14
11/16	256.61	201.54	75.473	59.276	11/16	464.43	364.76	136.60	107.28
3/4	260.31	204.45	76.563	60.132	3/4	469.41	368.68	138.06	108.43
13/16	264.04	207.38	77.660	60.994	13/16	474.42	372.61	139.54	109.59
7/8	267.80	210.33	78.766	61.863	7/8	479.45	376.56	141.02	110.75
15/16	271.59	213.30	79.879	62.737	15/16	484.51	380.54	142.50	111.92
9	275.40	216.30	81.000	63.617	12	489.60	384.53	144.00	113.10
1/16	279.24	219.31	82.129	64.504	1/8	499.85	392.58	147.02	115.47
1/8	283.10	222.35	83.266	65.397	1/4	510.21	400.72	150.06	117.86
3/16	286.99	225.40	84.410	66.296	3/8	520.68	408.94	153.14	120.28
1/4	290.91	228.48	85.563	67.201	1/2	531.25	417.24	156.25	122.72
5/16	294.86	231.58	86.723	68.112	5/8	541.93	425.63	159.39	125.19
3/8	298.83	234.70	87.891	69.029	3/4	552.71	434.10	162.56	127.68
7/16	302.83	237.84	89.066	69.953	7/8	563.60	442.65	165.77	130.19
1/2	306.85	241.00	90.250	70.882	13	574.60	451.29	169.00	132.73
9/16	310.90	244.18	91.441	71.818	1/8	585.70	460.01	172.27	135.30
5/8	314.98	247.38	92.641	72.760	1/4	596.91	468.82	175.56	137.89
11/16	319.08	250.61	93.848	73.708	3/8	608.23	477.70	178.89	140.50
3/4	323.21	253.85	95.063	74.662	1/2	619.65	486.67	182.25	143.14
13/16	327.37	257.12	96.285	75.622	5/8	631.18	495.73	185.64	145.80
7/8	331.55	260.40	97.516	76.589	3/4	642.81	504.86	189.06	148.49
15/16	335.76	263.71	98.754	77.561	7/8	654.55	514.09	192.52	151.20
10	340.00	267.04	100.00	78.540	14	666.40	523.39	196.00	153.94
1/16	344.26	270.38	101.25	79.525	1/8	678.35	532.78	199.52	156.70
1/8	348.55	273.75	102.52	80.516	1/4	690.41	542.25	203.06	159.49
3/16	352.87	277.14	103.79	81.513	3/8	702.58	551.80	206.64	162.30
1/4	357.21	280.55	105.06	82.516	1/2	714.85	561.44	210.25	165.13
5/16	361.58	283.99	106.35	83.525	5/8	727.23	571.16	213.89	167.99
3/8	365.98	287.44	107.64	84.541	3/4	739.71	580.97	217.56	170.87
7/16	370.40	290.91	108.94	85.563	7/8	752.30	590.86	221.27	173.78
1/2	374.85	294.41	110.25	86.590	15	765.00	600.83	225.00	176.72
9/16	379.33	297.92	111.57	87.624	1/8	777.80	610.89	228.77	179.67
5/8	383.83	301.46	112.89	88.664	1/4	790.71	621.03	232.56	182.65
11/16	388.36	305.01	114.22	89.710	3/8	803.73	631.25	236.39	185.66
3/4	392.91	308.59	115.56	90.763	1/2	816.85	641.55	240.25	188.69
13/16	397.49	312.19	116.91	91.821	5/8	830.08	651.94	244.14	191.75
7/8	402.10	315.81	118.27	92.886	3/4	843.41	662.42	248.06	194.83
15/16	406.74	319.45	119.63	93.957	7/8	856.85	672.97	252.02	197.93

16—27 7/8

WEIGHTS AND AREAS OF SQUARE AND ROUND BARS

Size or Diameter Inches	Weight, Lbs. per Ft.		Area, Sq. In.		Size or Diameter Inches	Weight, Lbs. per Ft.		Area, Sq. In.	
	Square	Round	Square	Round		Square	Round	Square	Round
16	870.40	683.61	256.00	201.06	22	1645.6	1292.5	484.00	380.13
1/8	884.05	694.34	260.02	204.22	1/8	1664.4	1307.2	489.52	384.47
1/4	897.81	705.14	264.06	207.39	1/4	1683.2	1322.0	495.06	388.82
3/8	911.68	716.03	268.14	210.60	3/8	1702.2	1336.9	500.64	393.20
1/2	925.65	727.01	272.25	213.83	1/2	1721.3	1351.9	506.25	397.61
5/8	939.73	738.06	276.39	217.08	5/8	1740.4	1366.9	511.89	402.04
3/4	953.91	749.20	280.56	220.35	3/4	1759.7	1382.1	517.56	406.49
7/8	968.20	760.43	284.77	223.65	7/8	1779.1	1397.3	523.27	410.97
17	982.60	771.73	289.00	226.98	23	1798.6	1412.6	529.00	415.48
1/8	997.10	783.12	293.27	230.33	1/8	1818.2	1428.0	534.77	420.00
1/4	1011.71	794.60	297.56	233.71	1/4	1837.9	1443.5	540.56	424.56
3/8	1026.43	806.16	301.89	237.10	3/8	1857.7	1459.1	546.39	429.14
1/2	1041.25	817.80	306.25	240.53	1/2	1877.7	1474.7	552.25	433.74
5/8	1056.18	829.52	310.64	243.98	5/8	1897.7	1490.4	558.14	438.36
3/4	1071.21	841.33	315.06	247.45	3/4	1917.8	1506.2	564.06	443.01
7/8	1086.35	853.22	319.52	250.95	7/8	1938.1	1522.1	570.02	447.69
18	1101.60	865.20	324.00	254.47	24	1958.4	1538.1	576.00	452.39
1/8	1117.0	877.25	328.52	258.02	1/8	1978.9	1554.2	582.02	457.12
1/4	1132.4	889.40	333.06	261.59	1/4	1999.4	1570.3	588.06	461.86
3/8	1148.0	901.62	337.64	265.18	3/8	2020.1	1586.6	594.14	466.64
1/2	1163.7	913.93	342.25	268.80	1/2	2040.9	1602.9	600.25	471.44
5/8	1179.4	926.32	346.89	272.45	5/8	2061.7	1619.3	606.39	476.26
3/4	1195.3	938.80	351.56	276.12	3/4	2082.7	1635.8	612.56	481.11
7/8	1211.3	951.36	356.27	279.81	7/8	2103.8	1652.3	618.77	485.98
19	1227.4	964.00	361.00	283.53	25	2125.0	1669.0	625.00	490.88
1/8	1243.6	976.73	365.77	287.27	1/8	2146.3	1685.7	631.27	495.80
1/4	1259.9	989.54	370.56	291.04	1/4	2167.7	1702.5	637.56	500.74
3/8	1276.3	1002.43	375.39	294.83	3/8	2189.2	1719.4	643.89	505.71
1/2	1292.9	1015.40	380.25	298.65	1/2	2210.9	1736.4	650.25	510.71
5/8	1309.5	1028.46	385.14	302.49	5/8	2232.6	1753.5	656.64	515.73
3/4	1326.2	1041.6	390.06	306.35	3/4	2254.4	1770.6	663.06	520.77
7/8	1343.1	1054.8	395.02	310.24	7/8	2276.4	1787.8	669.52	525.84
20	1360.0	1068.1	400.00	314.16	26	2298.4	1805.2	676.00	530.93
1/8	1377.1	1081.5	405.02	318.10	1/8	2320.6	1822.6	682.52	536.05
1/4	1394.2	1095.0	410.06	322.06	1/4	2342.8	1840.0	689.06	541.19
3/8	1411.5	1108.6	415.14	326.05	3/8	2365.2	1857.6	695.64	546.36
1/2	1428.9	1122.2	420.25	330.06	1/2	2387.7	1875.3	702.25	551.55
5/8	1446.3	1135.9	425.39	334.10	5/8	2410.2	1893.0	708.89	556.76
3/4	1463.9	1149.8	430.56	338.16	3/4	2432.9	1910.8	715.56	562.00
7/8	1481.6	1163.7	435.77	342.25	7/8	2455.7	1928.7	722.27	567.27
21	1499.4	1177.6	441.00	346.36	27	2478.6	1946.7	729.00	572.56
1/8	1517.3	1191.7	446.27	350.50	1/8	2501.6	1964.8	735.77	577.87
1/4	1535.3	1205.8	451.56	354.66	1/4	2524.7	1982.9	742.56	583.21
3/8	1553.4	1220.1	456.89	358.84	3/8	2547.9	2001.1	749.39	588.57
1/2	1571.7	1234.4	462.25	363.05	1/2	2571.3	2019.5	756.25	593.96
5/8	1590.0	1248.8	467.64	367.28	5/8	2594.7	2037.9	763.14	599.37
3/4	1608.4	1263.2	473.06	371.54	3/4	2618.2	2056.3	770.06	604.81
7/8	1627.0	1277 8	478.52	375.83	7/8	2641.9	2074.9	777.02	610.27

28—43¾

WEIGHTS AND AREAS OF SQUARE AND ROUND BARS

Size or Diameter Inches	Weight, Lbs. per Ft.		Area, Sq. In.		Size or Diameter Inches	Weight, Lbs. per Ft.		Area, Sq. In.	
	Square ■	Round ●	Square ▨	Round ◍		Square ■	Round ●	Square ▨	Round ◍
28	2665.6	2093.6	784.00	615.75	34	3930.4	3086.9	1156.00	907.92
⅛	2689.5	2112.3	791.02	621.26	⅛	3959.4	3109.7	1164.52	914.61
¼	2713.4	2131.1	798.06	626.80	¼	3988.4	3132.5	1173.06	921.32
⅜	2737.5	2150.0	805.14	632.36	⅜	4017.6	3155.4	1181.64	928.06
½	2761.7	2169.0	812.25	637.94	½	4046.9	3178.4	1190.25	934.82
⅝	2785.9	2188.1	819.39	643.55	⅝	4076.2	3201.5	1198.89	941.61
¾	2810.3	2207.2	826.56	649.18	¾	4105.7	3224.6	1207.56	948.42
⅞	2834.8	2226.5	833.77	654.84	⅞	4135.3	3247.9	1216.27	955.26
29	2859.4	2245.8	841.00	660.52	35	4165.0	3271.2	1225.00	962.12
⅛	2884.1	2265.2	848.27	666.23	⅛	4194.8	3294.6	1233.77	969.00
¼	2908.9	2284.7	855.56	671.96	¼	4224.7	3318.1	1242.56	975.91
⅜	2933.8	2304.2	862.89	677.71	⅜	4254.7	3341.7	1251.39	982.84
½	2958.9	2323.9	870.25	683.49	½	4284.9	3365.3	1260.25	989.80
⅝	2984.0	2343.6	877.64	689.30	⅝	4315.1	3389.1	1269.14	996.78
¾	3009.2	2363.4	885.06	695.13	¾	4345.4	3412.9	1278.06	1003.79
⅞	3034.6	2383.3	892.52	700.98	⅞	4375.9	3436.8	1287.02	1010.82
30	3060.0	2403.3	900.00	706.86	36	4406.4	3460.8	1296.00	1017.88
⅛	3085.6	2423.4	907.52	712.76	¼	4467.8	3509.0	1314.1	1032.1
¼	3111.2	2443.5	915.06	718.69	½	4529.7	3557.6	1332.3	1046.4
⅜	3137.0	2463.8	922.64	724.64	¾	4591.9	3606.5	1350.6	1060.7
½	3162.9	2484.1	930.25	730.62	37	4654.6	3655.7	1369.0	1075.2
⅝	3188.8	2504.5	937.89	736.62	¼	4717.7	3705.3	1387.6	1089.8
¾	3214.9	2525.0	945.56	742.64	½	4781.3	3755.2	1406.3	1104.5
⅞	3241.1	2545.6	953.27	748.69	¾	4845.2	3805.4	1425.1	1119.2
31	3267.4	2566.2	961.00	754.77	38	4909.6	3856.0	1444.0	1134.1
⅛	3293.8	2587.0	968.77	760.87	¼	4974.4	3906.9	1463.1	1149.1
¼	3320.3	2607.8	976.56	766.99	½	5039.7	3958.1	1482.3	1164.2
⅜	3346.9	2628.7	984.39	773.14	¾	5105.3	4009.7	1501.6	1179.3
½	3373.7	2649.7	992.25	779.31	39	5171.4	4061.6	1521.0	1194.6
⅝	3400.5	2670.7	1000.14	785.51	¼	5237.9	4113.9	1540.6	1210.0
¾	3427.4	2691.9	1008.06	791.73	½	5304.9	4166.4	1560.3	1225.4
⅞	3454.5	2713.1	1016.02	797.98	¾	5372.2	4219.3	1580.1	1241.0
32	3481.6	2734.4	1024.00	804.25	40	5440.0	4272.6	1600.0	1256.6
⅛	3508.9	2755.9	1032.02	810.55	¼	5508.2	4326.2	1620.1	1272.4
¼	3536.2	2777.3	1040.06	816.87	½	5576.9	4380.1	1640.3	1288.3
⅜	3563.7	2798.9	1048.14	823.21	¾	5645.9	4434.3	1660.6	1304.2
½	3591.3	2820.6	1056.25	829.58	41	5715.4	4488.9	1681.0	1320.3
⅝	3618.9	2842.3	1064.39	835.97	¼	5785.3	4543.8	1701.6	1336.4
¾	3646.7	2864.1	1072.56	842.39	½	5855.7	4599.0	1722.3	1352.7
⅞	3674.6	2886.0	1080.77	848.83	¾	5926.4	4654.6	1743.1	1369.0
33	3702.6	2908.0	1089.00	855.30	42	5997.6	4710.5	1764.0	1385.5
⅛	3730.7	2930.1	1097.27	861.79	¼	6069.2	4766.8	1785.1	1402.0
¼	3758.9	2952.2	1105.56	868.31	½	6141.3	4823.3	1806.3	1418.6
⅜	3787.2	2974.5	1113.89	874.85	¾	6213.7	4880.2	1827.6	1435.4
½	3815.7	2996.8	1122.25	881.42	43	6286.6	4937.5	1849.0	1452.2
⅝	3844.2	3019.2	1130.64	888.01	¼	6359.9	4995.1	1870.6	1469.1
¾	3872.8	3041.7	1139.06	894.62	½	6433.7	5053.0	1892.3	1486.2
⅞	3901.6	3064.3	1147.52	901.26	¾	6507.8	5111.2	1914.1	1503.3

WEIGHTS AND AREAS OF SQUARE AND ROUND BARS

Size or Diameter Inches	Weight, Lbs. per Ft. Square	Weight, Lbs. per Ft. Round	Area, Sq. In. Square	Area, Sq. In. Round	Size or Diameter Inches	Weight, Lbs. per Ft. Square	Weight, Lbs. per Ft. Round	Area, Sq. In. Square	Area, Sq. In. Round
44	6582.4	5169.8	1936.0	1520.5	56	10662.4	8374.2	3136.0	2463.0
¼	6657.4	5228.7	1958.1	1537.9	¼	10757.8	8449.2	3164.1	2485.1
½	6732.9	5288.0	1980.3	1555.3	½	10853.7	8524.5	3192.3	2507.2
¾	6808.7	5347.6	2002.6	1572.8	¾	10949.9	8600.1	3220.6	2529.4
45	6885.0	5407.5	2025.0	1590.4	57	11046.6	8676.0	3249.0	2551.8
¼	6961.7	5467.7	2047.6	1608.2	¼	11143.7	8752.3	3277.6	2574.2
½	7038.9	5528.3	2070.3	1626.0	½	11241.3	8828.9	3306.3	2596.7
¾	7116.4	5589.2	2093.1	1643.9	¾	11339.2	8905.8	3335.1	2619.4
46	7194.4	5650.5	2116.0	1661.9	58	11437.6	8983.1	3364.0	2642.1
¼	7272.8	5712.1	2139.1	1680.0	¼	11536.4	9060.7	3393.1	2664.9
½	7351.7	5774.0	2162.3	1698.2	½	11635.7	9138.6	3422.3	2687.8
¾	7430.9	5836.2	2185.6	1716.5	¾	11735.3	9216.9	3451.6	2710.9
47	7510.6	5898.8	2209.0	1734.9	59	11835.4	9295.5	3481.0	2734.0
¼	7590.7	5961.7	2232.6	1753.5	¼	11935.9	9374.5	3510.6	2757.2
½	7671.3	6025.0	2256.3	1772.1	½	12036.9	9453.7	3540.3	2780.5
¾	7752.2	6088.6	2280.1	1790.8	¾	12138.2	9533.4	3570.1	2803.9
48	7833.6	6152.5	2304.0	1809.6	60	12240.0	9613.3	3600.0	2827.4
¼	7915.4	6216.8	2328.1	1828.5	¼	12342	9693.6	3630.1	2851.1
½	7997.7	6281.4	2352.3	1847.5	½	12445	9774.2	3660.3	2874.8
¾	8080.3	6346.3	2376.6	1866.6	¾	12548	9855.1	3690.6	2898.6
49	8163.4	6411.5	2401.0	1885.7	61	12651	9936.4	3721.0	2922.5
¼	8246.9	6477.1	2425.6	1905.0	¼	12755	10018.0	3751.6	2946.5
½	8330.9	6543.0	2450.3	1924.4	½	12860	10100.0	3782.3	2970.6
¾	8415.2	6609.3	2475.1	1943.9	¾	12964	10182.2	3813.1	2994.8
50	8500.0	6675.9	2500.0	1963.5	62	13070	10264.9	3844.0	3019.1
¼	8585.2	6742.8	2525.1	1983.2	¼	13175	10347.8	3875.1	3043.5
½	8670.9	6810.1	2550.3	2003.0	½	13281	10431.1	3906.3	3068.0
¾	8756.9	6877.7	2575.6	2022.8	¾	13388	10514.7	3937.6	3092.6
51	8843.4	6945.6	2601.0	2042.8	63	13495	10598.7	3969.0	3117.3
¼	8930.3	7013.9	2626.6	2062.9	¼	13602	10682.9	4000.6	3142.0
½	9017.7	7082.5	2652.3	2083.1	½	13710	10767.6	4032.3	3166.9
¾	9105.4	7151.4	2678.1	2103.4	¾	13818	10852.5	4064.1	3191.9
52	9193.6	7220.7	2704.0	2123.7	64	13926	10937.8	4096.0	3217.0
¼	9282.2	7290.2	2730.1	2144.2	¼	14035	11023.4	4128.1	3242.2
½	9371.3	7360.2	2756.3	2164.8	½	14145	11109.4	4160.3	3267.5
¾	9460.7	7430.4	2782.6	2185.4	¾	14255	11195.7	4192.6	3292.8
53	9550.6	7501.0	2809.0	2206.2	65	14365	11282.3	4225.0	3318.3
¼	9640.9	7572.0	2835.6	2227.1	¼	14476	11369.2	4257.6	3343.9
½	9731.7	7643.2	2862.3	2248.0	½	14587	11456.5	4290.3	3369.6
¾	9822.8	7714.8	2889.1	2269.1	¾	14698	11544.1	4323.1	3395.3
54	9914.4	7786.8	2916.0	2290.2	66	14810	11632.1	4356.0	3421.2
¼	10006.4	7859.0	2943.1	2311.5	¼	14923	11720.4	4389.1	3447.2
½	10098.9	7931.6	2970.3	2332.8	½	15036	11809.0	4422.3	3473.2
¾	10191.7	8004.6	2997.6	2354.3	¾	15149	11898.0	4455.6	3499.4
55	10285.0	8077.8	3025.0	2375.8	67	15263	11987.2	4489.0	3525.7
¼	10378.7	8151.4	3052.6	2397.5	¼	15377	12076.9	4522.6	3552.0
½	10472.9	8225.4	3080.3	2419.2	½	15491	12166.8	4556.3	3578.5
¾	10567.4	8299.6	3108.1	2441.1	¾	15606	12257.1	4590.1	3605.0

68—91¾

WEIGHTS AND AREAS OF SQUARE AND ROUND BARS

Size or Diameter Inches	Weight, Lbs. per Ft. Square	Weight, Lbs. per Ft. Round	Area, Sq. In. Square	Area, Sq. In. Round	Size or Diameter Inches	Weight, Lbs. per Ft. Square	Weight, Lbs. per Ft. Round	Area, Sq. In. Square	Area, Sq. In. Round
68	15722	12347.7	4624.0	3631.7	80	21760	17090	6400.0	5026.5
¼	15837	12438.7	4658.1	3658.4	¼	21896	17197	6440.1	5058.0
½	15954	12530.0	4692.3	3685.3	½	22033	17305	6480.3	5089.6
¾	16070	12621.6	4726.6	3712.2	¾	22170	17412	6520.6	5121.2
69	16187	12713.6	4761.0	3739.3	81	22307	17520	6561.0	5153.0
¼	16305	12805.9	4795.6	3766.4	¼	22445	17629	6601.6	5184.9
½	16423	12898.5	4830.3	3793.7	½	22584	17737	6642.3	5216.8
¾	16541	12991.5	4865.1	3821.0	¾	22722	17846	6683.1	5248.9
70	16660	13084.8	4900.0	3848.5	82	22862	17955	6724.0	5281.0
¼	16779	13178.4	4935.1	3876.0	¼	23001	18065	6765.1	5313.3
½	16899	13272.4	4970.3	3903.6	½	23141	18175	6806.3	5345.6
¾	17019	13366.7	5005.6	3931.4	¾	23282	18285	6847.6	5378.1
71	17139	13461.3	5041.0	3959.2	83	23423	18396	6889.0	5410.6
¼	17260	13556.2	5076.6	3987.1	¼	23564	18507	6930.6	5443.3
½	17382	13651.5	5112.3	4015.2	½	23706	18618	6972.3	5476.0
¾	17503	13747.2	5148.1	4043.3	¾	23848	18730	7014.1	5508.8
72	17626	13843.1	5184.0	4071.5	84	23990	18842	7056.0	5541.8
¼	17748	13939	5220.1	4099.8	¼	24133	18954	7098.1	5574.8
½	17871	14036	5256.3	4128.2	½	24277	19067	7140.3	5607.9
¾	17995	14133	5292.6	4156.8	¾	24421	19180	7182.6	5641.2
73	18119	14230	5329.0	4185.4	85	24565	19293	7225.0	5674.5
¼	18243	14328	5365.6	4214.1	¼	24710	19407	7267.6	5707.9
½	18368	14426	5402.3	4242.9	½	24855	19521	7310.3	5741.5
¾	18493	14524	5439.1	4271.8	¾	25000	19635	7353.1	5775.1
74	18618	14623	5476.0	4300.8	86	25146	19750	7396.0	5808.8
¼	18744	14722	5513.1	4329.9	¼	25293	19865	7439.1	5842.6
½	18871	14821	5550.3	4359.2	½	25440	19980	7482.3	5876.5
¾	18998	14921	5587.6	4388.5	¾	25587	20096	7525.6	5910.6
75	19125	15021	5625.0	4417.9	87	25735	20212	7569.0	5944.7
¼	19253	15121	5662.6	4447.4	¼	25883	20328	7612.6	5978.9
½	19381	15222	5700.3	4477.0	½	26031	20445	7656.3	6013.2
¾	19509	15323	5738.1	4506.7	¾	26180	20562	7700.1	6047.6
76	19638	15424	5776.0	4536.5	88	26330	20679	7744.0	6082.1
¼	19768	15526	5814.1	4566.4	¼	26479	20797	7788.1	6116.7
½	19898	15628	5852.3	4596.3	½	26630	20915	7832.3	6151.4
¾	20028	15730	5890.6	4626.4	¾	26780	21033	7876.6	6186.2
77	20159	15833	5929.0	4656.6	89	26931	21152	7921.0	6221.1
¼	20290	15936	5967.6	4686.9	¼	27083	21271	7965.6	6256.1
½	20421	16039	6006.3	4717.3	½	27235	21390	8010.3	6291.2
¾	20553	16142	6045.1	4747.8	¾	27387	21510	8055.1	6326.4
78	20686	16246	6084.0	4778.4	90	27540	21630	8100.0	6361.7
¼	20818	16351	6123.1	4809.0	¼	27693	21750	8145.1	6397.1
½	20952	16455	6162.3	4839.8	½	27847	21871	8190.3	6432.6
¾	21085	16560	6201.6	4870.7	¾	28001	21992	8235.6	6468.2
79	21219	16666	6241.0	4901.7	91	28155	22113	8281.0	6503.9
¼	21354	16771	6280.6	4932.7	¼	28310	22235	8326.6	6539.7
½	21489	16877	6320.3	4963.9	½	28466	22357	8372.3	6575.5
¾	21624	16984	6360.1	4995.2	¾	28621	22479	8418.1	6611.5

92—115 3/4

WEIGHTS AND AREAS OF SQUARE AND ROUND BARS

Size or Diameter Inches	Weight, Lbs. per Ft. Square	Weight, Lbs. per Ft. Round	Area, Sq. In. Square	Area, Sq. In. Round	Size or Diameter Inches	Weight, Lbs. per Ft. Square	Weight, Lbs. per Ft. Round	Area, Sq. In. Square	Area, Sq. In. Round
92	28778	22602	8464.0	6647.6	104	36774	28883	10816	8494.9
1/4	28934	22725	8510.1	6683.8	1/4	36951	29022	10868	8535.8
1/2	29091	22848	8556.3	6720.1	1/2	37129	29161	10920	8576.7
3/4	29249	22972	8602.6	6756.4	3/4	37307	29301	10973	8617.8
93	29407	23096	8649.0	6792.9	105	37485	29441	11025	8659.0
1/4	29565	23220	8695.6	6829.5	1/4	37664	29581	11078	8700.3
1/2	29724	23345	8742.3	6866.1	1/2	37843	29722	11130	8741.7
3/4	29883	23470	8789.1	6902.9	3/4	38022	29863	11183	8783.2
94	30042	23595	8836.0	6939.8	106	38202	30004	11236	8824.7
1/4	30202	23721	8883.1	6976.7	1/4	38383	30146	11289	8866.4
1/2	30363	23847	8930.3	7013.8	1/2	38564	30288	11342	8908.2
3/4	30524	23973	8977.6	7051.0	3/4	38745	30430	11396	8950.1
95	30685	24100	9025.0	7088.2	107	38927	30573	11449	8992.0
1/4	30847	24227	9072.6	7125.6	1/4	39109	30716	11503	9034.1
1/2	31009	24354	9120.3	7163.0	1/2	39291	30859	11556	9076.3
3/4	31171	24481	9168.1	7200.6	3/4	39474	31003	11610	9118.5
96	31334	24610	9216.0	7238.2	108	39658	31147	11664	9160.9
1/4	31498	24738	9264.1	7276.0	1/4	39841	31291	11718	9203.3
1/2	31662	24867	9312.3	7313.8	1/2	40026	31436	11772	9245.9
3/4	31826	24996	9360.6	7351.8	3/4	40210	31581	11827	9288.6
97	31991	25125	9409.0	7389.8	109	40395	31726	11881	9331.3
1/4	32156	25255	9457.6	7428.0	1/4	40581	31872	11936	9374.2
1/2	32321	25385	9506.3	7466.2	1/2	40767	32018	11990	9417.1
3/4	32487	25515	9555.1	7504.5	3/4	40953	32165	12045	9460.2
98	32654	25646	9604.0	7543.0	110	41140	32311	12100	9503.3
1/4	32820	25777	9653.1	7581.5	1/4	41327	32458	12155	9546.6
1/2	32988	25908	9702.3	7620.1	1/2	41515	32606	12210	9589.9
3/4	33155	26040	9751.6	7658.9	3/4	41703	32753	12266	9633.4
99	33323	26172	9801.0	7697.7	111	41891	32901	12321	9676.9
1/4	33492	26304	9850.6	7736.6	1/4	42080	33050	12377	9720.5
1/2	33661	26437	9900.3	7775.6	1/2	42270	33199	12432	9764.3
3/4	33830	26570	9950.1	7814.8	3/4	42459	33348	12488	9808.1
100	34000	26704	10000	7854.0	112	42650	33497	12544	9852.0
1/4	34170	26837	10050	7893.3	1/4	42840	33647	12600	9896.1
1/2	34341	26971	10100	7932.7	1/2	43031	33797	12656	9940.2
3/4	34512	27106	10151	7972.2	3/4	43223	33947	12713	9984.4
101	34683	27240	10201	8011.8	113	43415	34098	12769	10029
1/4	34855	27375	10252	8051.6	1/4	43607	34249	12826	10073
1/2	35028	27511	10302	8091.4	1/2	43800	34400	12882	10118
3/4	35200	27646	10353	8131.3	3/4	43993	34552	12939	10162
102	35374	27782	10404	8171.3	114	44186	34704	12996	10207
1/4	35547	27919	10455	8211.4	1/4	44380	34856	13053	10252
1/2	35721	28055	10506	8251.6	1/2	44575	35009	13110	10297
3/4	35896	28192	10558	8291.9	3/4	44770	35162	13168	10342
103	36071	28330	10609	8332.3	115	44965	35315	13225	10387
1/4	36246	28467	10661	8372.8	1/4	45161	35469	13283	10432
1/2	36422	28605	10712	8413.4	1/2	45357	35623	13340	10477
3/4	36598	28744	10764	8454.1	3/4	45553	35778	13398	10523

WEIGHTS AND AREAS OF SQUARE AND ROUND BARS

Size or Diameter Inches	Weight, Lbs. per Ft. Square	Weight, Lbs. per Ft. Round	Area, Sq. In. Square	Area, Sq. In. Round	Size or Diameter Inches	Weight, Lbs. per Ft. Square	Weight, Lbs. per Ft. Round	Area, Sq. In. Square	Area, Sq. In. Round
116	45750	35932	13456	10568	128	55706	43751	16384	12868
¼	45948	36087	13514	10614	¼	55923	43922	16448	12918
½	46146	36243	13572	10660	½	56142	44094	16512	12969
¾	46344	36398	13631	10705	¾	56360	44265	16577	13019
117	46543	36554	13689	10751	129	56579	44437	16641	13070
¼	46742	36711	13748	10797	¼	56799	44610	16706	13121
½	46941	36868	13806	10843	½	57019	44783	16770	13171
¾	47141	37025	13865	10890	¾	57239	44956	16835	13222
118	47342	37182	13924	10936	130	57460	45129	16900	13273
¼	47542	37340	13983	10982	¼	57681	45303	16965	13324
½	47744	37498	14042	11029	½	57903	45477	17030	13376
¾	47945	37656	14102	11075	¾	58125	45651	17096	13427
119	48147	37815	14161	11122	131	58347	45826	17161	13478
¼	48350	37974	14221	11169	¼	58570	46001	17227	13530
½	48553	38133	14280	11216	½	58794	46177	17292	13581
¾	48756	38293	14340	11263	¾	59017	46352	17358	13633
120	48960	38453	14400	11310	132	59242	46528	17424	13685
¼	49164	38614	14460	11357	¼	59466	46705	17490	13737
½	49369	38774	14520	11404	½	59691	46882	17556	13789
¾	49574	38935	14581	11452	¾	59917	47059	17623	13841
121	49779	39097	14641	11499	133	60143	47236	17689	13893
¼	49985	39258	14702	11547	¼	60369	47414	17756	13945
½	50192	39421	14762	11594	½	60596	47592	17822	13998
¾	50398	39583	14823	11642	¾	60823	47770	17889	14050
122	50606	39746	14884	11690	134	61050	47949	17956	14103
¼	50813	39909	14945	11738	¼	61278	48128	18023	14155
½	51021	40072	15006	11786	½	61507	48307	18090	14208
¾	51230	40236	15068	11834	¾	61736	48487	18158	14261
123	51439	40400	15129	11882	135	61965	48667	18225	14314
¼	51648	40564	15191	11931	¼	62195	48848	18293	14367
½	51858	40729	15252	11979	½	62425	49028	18360	14420
¾	52068	40894	15314	12028	¾	62655	49210	18428	14473
124	52278	41059	15376	12076	136	62886	49391	18496	14527
¼	52489	41225	15438	12125	¼	63118	49573	18564	14580
½	52701	41391	15500	12174	½	63350	49755	18632	14634
¾	52913	41558	15563	12223	¾	63582	49937	18701	14687
125	53125	41724	15625	12272	137	63815	50120	18769	14741
¼	53337	41891	15688	12321	¼	64048	50303	18838	14795
½	53551	42059	15750	12370	½	64281	50486	18906	14849
¾	53764	42227	15813	12420	¾	64515	50670	18975	14903
126	53978	42395	15876	12469	138	64750	50854	19044	14957
¼	54193	42563	15939	12519	¼	64984	51039	19113	15011
½	54408	42732	16002	12568	½	65220	51224	19182	15066
¾	54623	42901	16066	12618	¾	65455	51409	19252	15120
127	54839	43070	16129	12668	139	65691	51594	19321	15175
¼	55055	43240	16193	12718	¼	65928	51780	19391	15229
½	55271	43410	16256	12768	½	66165	51966	19460	15284
¾	55488	43580	16320	12818	¾	66402	52152	19530	15339

WEIGHTS AND AREAS OF SQUARE AND ROUND BARS

Size or Diameter Inches	Weight, Lbs. per Ft.		Area, Sq. In.	
	Square	Round	Square	Round
140	66640	52339	19600	15394
¼	66878	52526	19670	15449
½	67117	52714	19740	15504
¾	67356	52901	19811	15559
141	67595	53089	19881	15615
¼	67835	53278	19952	15670
½	68076	53467	20022	15725
¾	68316	53656	20093	15781
142	68558	53845	20164	15837
¼	68799	54035	20235	15893
½	69041	54225	20306	15949
¾	69284	54415	20378	16005
143	69527	54606	20449	16061
¼	69770	54797	20521	16117
½	70014	54989	20592	16173
¾	70258	55180	20664	16230
144	70502	55373	20736	16286
¼	70747	55565	20808	16343
½	70993	55758	20880	16399
¾	71239	55951	20953	16456
145	71485	56144	21025	16513
¼	71732	56338	21098	16570
½	71979	56532	21170	16627
¾	72226	56727	21243	16684
146	72474	56921	21316	16742
¼	72723	57116	21389	16799
½	72972	57312	21462	16856
¾	73221	57508	21536	16914
147	73471	57704	21609	16972
¼	73721	57900	21683	17029
½	73971	58097	21756	17087
¾	74222	58294	21830	17145
148	74474	58492	21904	17203
¼	74725	58689	21978	17262
½	74978	58887	22052	17320
¾	75230	59086	22127	17378
149	75483	59285	22201	17437
¼	75737	59484	22276	17495
½	75991	59683	22350	17554
¾	76245	59883	22425	17613
150	76500	60083	22500	17672
¼	76755	60284	22575	17730
½	77011	60484	22650	17790
¾	77267	60685	22726	17849
151	77523	60887	22801	17908
¼	77780	61089	22877	17967
½	78038	61291	22952	18027
¾	78295	61493	23028	18086
152	78554	61696	23104	18146
¼	78812	61899	23180	18206
½	79071	62103	23256	18265
¾	79331	62306	23333	18325
153	79591	62510	23409	18385
¼	79851	62715	23486	18446
½	80112	62920	23562	18506
¾	80373	63125	23639	18566
154	80634	63330	23716	18627
¼	80896	63536	23793	18687
½	81159	63742	23870	18748
¾	81422	63949	23948	18808
155	81685	64155	24025	18869
¼	81949	64363	24103	18930
½	82213	64570	24180	18991
¾	82477	64778	24258	19052
156	82742	64986	24336	19113
¼	83008	65194	24414	19175
½	83274	65403	24492	19236
¾	83540	65612	24571	19298
157	83807	65822	24649	19359
¼	84074	66031	24728	19421
½	84341	66242	24806	19483
¾	84609	66452	24885	19545
158	84878	66663	24964	19607
¼	85146	66874	25043	19669
½	85416	67085	25122	19731
¾	85685	67297	25202	19793
159	85955	67509	25281	19856
¼	86226	67722	25361	19918
½	86497	67935	25440	19981
¾	86768	68148	25520	20043
160	87040	68361	25600	20106
¼	87312	68575	25680	20169
½	87585	68789	25760	20232
¾	87858	69004	25841	20295
161	88131	69218	25921	20358
¼	88405	69434	26002	20422
½	88680	69649	26082	20485
¾	88954	69865	26163	20548
162	89230	70081	26244	20612
¼	89505	70297	26325	20676
½	89781	70514	26406	20739
¾	90058	70731	26488	20803
163	90335	70949	26569	20867
¼	90612	71167	26651	20931
½	90890	71385	26732	20996
¾	91168	71603	26814	21060

164—180

WEIGHTS AND AREAS OF
SQUARE AND ROUND BARS

Size or Diameter Inches	Weight, Lbs. per Ft.		Area, Sq. In.	
	Square	Round	Square	Round
164	91446	71822	26896	21124
¼	91725	72041	26978	21189
½	92005	72261	27060	21253
¾	92285	72480	27143	21318
165	92565	72701	27225	21383
¼	92846	72921	27308	21447
½	93127	73142	27390	21512
¾	93408	73363	27473	21577
166	93690	73584	27556	21642
¼	93973	73806	27639	21708
½	94256	74028	27722	21773
¾	94539	74251	27806	21838
167	94823	74474	27889	21904
¼	95107	74697	27973	21970
½	95391	74920	28056	22035
¾	95676	75144	28140	22101
168	95962	75368	28224	22167
¼	96247	75593	28308	22233
½	96534	75817	28392	22299
¾	96820	76042	28477	22365
169	97107	76268	28561	22432
¼	97395	76494	28646	22498
½	97682	76720	28730	22565
¾	97971	76946	28815	22631
170	98260	77173	28900	22698
¼	98549	77400	28985	22765
½	98839	77628	29070	22832
¾	99129	77856	29156	22899
171	99419	78084	29241	22966
¼	99710	78312	29327	23033
½	100002	78541	29412	23100
¾	100293	78770	29498	23168

Size or Diameter Inches	Weight, Lbs. per Ft.		Area, Sq. In.	
	Square	Round	Square	Round
172	100586	79000	29584	23235
¼	100878	79230	29670	23303
½	101171	79460	29756	23371
¾	101465	79690	29843	23438
173	101759	79921	29929	23506
¼	102053	80152	30016	23574
½	102348	80384	30102	23642
¾	102643	80615	30189	23710
174	102938	80848	30276	23779
¼	103234	81080	30363	23847
½	103531	81313	30450	23916
¾	103828	81546	30538	23984
175	104125	81780	30625	24053
¼	104423	82013	30713	24122
½	104721	82248	30800	24190
¾	105019	82482	30888	24259
176	105318	82717	30976	24328
¼	105618	82952	31064	24398
½	105918	83188	31152	24467
¾	106218	83423	31241	24536
177	106519	83660	31329	24606
¼	106820	83896	31418	24675
½	107121	84133	31506	24745
¾	107423	84370	31595	24815
178	107726	84607	31684	24885
¼	108028	84845	31773	24955
½	108332	85083	31862	25025
¾	108635	85322	31952	25095
179	108939	85561	32041	25165
¼	109244	85800	32131	25235
½	109549	86039	32220	25306
¾	109854	86279	32310	25376
180	110160	86519	32400	25447

WEIGHTS OF SQUARE AND ROUND BARS PER RUNNING INCH

ONE CUBIC INCH OF STEEL WEIGHS 0.2833 LBS.

Size or Diameter In.	Weight, Lbs. per In. Square	Weight, Lbs. per In. Round	Size or Diameter In.	Weight, Lbs. per In. Square	Weight, Lbs. per In. Round	Size or Diameter In.	Weight, Lbs. per In. Square	Weight, Lbs. per In. Round
			3	2.550	2.003	6	10.200	8.011
1/16	.....	.....	1/16	2.657	2.087	1/16	10.414	8.179
1/8	.....	.....	1/8	2.767	2.173	1/8	10.629	8.348
3/16	.00996	.....	3/16	2.879	2.261	3/16	10.847	8.520
1/4	.0177	.0139	1/4	2.993	2.350	1/4	11.068	8.693
5/16	.0277	.0217	5/16	3.109	2.442	5/16	11.290	8.867
3/8	.0398	.0313	3/8	3.227	2.535	3/8	11.515	9.044
7/16	.0542	.0426	7/16	3.348	2.629	7/16	11.742	9.222
1/2	.0708	.0556	1/2	3.471	2.726	1/2	11.971	9.402
9/16	.0896	.0704	9/16	3.596	2.824	9/16	12.202	9.584
5/8	.111	.0869	5/8	3.723	2.924	5/8	12.436	9.767
11/16	.134	.105	11/16	3.853	3.026	11/16	12.671	9.952
3/4	.159	.125	3/4	3.984	3.129	3/4	12.909	10.139
13/16	.187	.147	13/16	4.118	3.235	13/16	13.150	10.328
7/8	.217	.170	7/8	4.254	3.341	7/8	13.392	10.518
15/16	.249	.196	15/16	4.393	3.450	15/16	13.637	10.710
1	.283	.223	4	4.533	3.560	7	13.883	10.904
1/16	.320	.251	1/16	4.676	3.673	1/16	14.132	11.100
1/8	.359	.282	1/8	4.821	3.786	1/8	14.384	11.297
3/16	.400	.314	3/16	4.968	3.902	3/16	14.637	11.496
1/4	.443	.348	1/4	5.118	4.019	1/4	14.893	11.697
5/16	.488	.383	5/16	5.269	4.139	5/16	15.151	11.899
3/8	.536	.421	3/8	5.423	4.259	3/8	15.411	12.104
7/16	.585	.460	7/16	5.579	4.382	7/16	15.673	12.310
1/2	.637	.501	1/2	5.737	4.506	1/2	15.937	12.517
9/16	.692	.543	9/16	5.898	4.632	9/16	16.204	12.727
5/8	.748	.588	5/8	6.061	4.760	5/8	16.473	12.938
11/16	.807	.634	11/16	6.226	4.890	11/16	16.744	13.151
3/4	.868	.681	3/4	6.393	5.021	3/4	17.018	13.366
13/16	.931	.731	13/16	6.562	5.154	13/16	17.293	13.582
7/8	.996	.782	7/8	6.734	5.289	7/8	17.571	13.800
15/16	1.064	.835	15/16	6.907	5.425	15/16	17.851	14.020
2	1.133	.890	5	7.083	5.563	8	18.133	14.242
1/16	1.205	.947	1/16	7.262	5.703	1/16	18.418	14.465
1/8	1.279	1.005	1/8	7.442	5.845	1/8	18.704	14.690
3/16	1.356	1.065	3/16	7.625	5.988	3/16	18.993	14.917
1/4	1.434	1.127	1/4	7.809	6.133	1/4	19.284	15.146
5/16	1.515	1.190	5/16	7.996	6.280	5/16	19.578	15.376
3/8	1.598	1.255	3/8	8.186	6.429	3/8	19.873	15.608
7/16	1.683	1.322	7/16	8.377	6.579	7/16	20.171	15.842
1/2	1.771	1.391	1/2	8.571	6.732	1/2	20.471	16.078
9/16	1.860	1.461	9/16	8.767	6.885	9/16	20.773	16.315
5/8	1.952	1.533	5/8	8.965	7.041	5/8	21.077	16.554
11/16	2.046	1.607	11/16	9.165	7.198	11/16	21.384	16.795
3/4	2.143	1.683	3/4	9.368	7.357	3/4	21.693	17.037
13/16	2.241	1.760	13/16	9.572	7.518	13/16	22.004	17.282
7/8	2.342	1.839	7/8	9.779	7.681	7/8	22.317	17.528
15/16	2.445	1.920	15/16	9.989	7.845	15/16	22.632	17.775

WEIGHTS OF SQUARE AND ROUND BARS PER RUNNING INCH

ONE CUBIC INCH OF STEEL WEIGHS 0.2833 LBS.

Size or Diameter In.	Weight, Lbs. per In. Square	Weight, Lbs. per In. Round	Size or Diameter In.	Weight, Lbs. per In. Square	Weight, Lbs. per In. Round	Size or Diameter In.	Weight, Lbs. per In. Square	Weight, Lbs. per In. Round
9	22.950	18.025	12	40.800	32.044	18	91.800	72.100
1/16	23.270	18.276	1/8	41.654	32.715	1/8	93.079	73.104
1/8	23.592	18.529	1/4	42.518	33.393	1/4	94.368	74.116
3/16	23.916	18.784	3/8	43.390	34.078	3/8	96.665	75.135
1/4	24.243	19.040	1/2	44.271	34.770	1/2	96.971	76.161
5/16	24.571	19.298	5/8	45.161	35.469	5/8	98.286	77.193
3/8	24.902	19.558	3/4	46.059	36.175	3/4	99.609	78.233
7/16	25.235	19.820	7/8	46.967	36.888	7/8	100.94	79.280
1/2	25.571	20.083	13	47.883	37.607	19	102.28	80.333
9/16	25.908	20.348	1/8	48.809	38.334	1/8	103.63	81.394
5/8	26.248	20.615	1/4	49.743	39.068	1/4	104.99	82.461
11/16	26.590	20.884	3/8	50.686	39.808	3/8	106.36	83.535
3/4	26.934	21.154	1/2	51.637	40.556	1/2	107.74	84.617
13/16	27.281	21.426	5/8	52.598	41.311	5/8	109.12	85.705
7/8	27.629	21.700	3/4	53.568	42.072	3/4	110.52	86.800
15/16	27.980	21.976	7/8	54.546	42.840	7/8	111.92	87.903
10	28.333	22.253	14	55.533	43.616	20	113.33	89.012
1/16	28.689	22.532	1/8	56.529	44.398	1/8	114.75	90.128
1/8	29.046	22.813	1/4	57.534	45.187	1/4	116.18	91.251
3/16	29.406	23.095	3/8	58.548	45.984	3/8	117.62	92.381
1/4	29.768	23.380	1/2	59.571	46.787	1/2	119.07	93.518
5/16	30.132	23.665	5/8	60.602	47.597	5/8	120.53	94.662
3/8	30.498	23.953	3/4	61.643	48.414	3/4	121.99	95.813
7/16	30.867	24.243	7/8	62.692	49.238	7/8	123.47	96.971
1/2	31.237	24.534	15	63.750	50.069	21	124.95	98.135
9/16	31.610	24.827	1/8	64.817	50.907	1/8	126.44	99.307
5/8	31.986	25.121	1/4	65.893	51.752	1/4	127.94	100.49
11/16	32.363	25.418	3/8	66.977	52.604	3/8	129.45	101.67
3/4	32.743	25.716	1/2	68.071	53.463	1/2	130.97	102.86
13/16	33.125	26.016	5/8	69.173	54.328	5/8	132.50	104.06
7/8	33.509	26.318	3/4	70.284	55.201	3/4	134.03	105.27
15/16	33.895	26.621	7/8	71.404	56.081	7/8	135.58	106.48
11	34.283	26.926	16	72.533	56.968	22	137.13	107.70
1/16	34.674	27.233	1/8	73.671	57.861	1/8	138.70	108.93
1/8	35.067	27.542	1/4	74.818	58.762	1/4	140.27	110.17
3/16	35.462	27.852	3/8	75.973	59.669	3/8	141.85	111.41
1/4	35.859	28.164	1/2	77.137	60.584	1/2	143.44	112.66
5/16	36.259	28.478	5/8	78.311	61.505	5/8	145.04	113.91
3/8	36.661	28.793	3/4	79.493	62.433	3/4	146.64	115.17
7/16	37.065	29.111	7/8	80.684	63.369	7/8	148.26	116.44
1/2	37.471	29.430	17	81.883	64.311	23	149.88	117.72
9/16	37.879	29.750	1/8	83.092	65.260	1/8	151.52	119.00
5/8	38.290	30.073	1/4	84.309	66.216	1/4	153.16	120.29
11/16	38.703	30.397	3/8	85.536	67.180	3/8	154.81	121.59
3/4	39.118	30.723	1/2	86.771	68.150	1/2	156.47	122.89
13/16	39.535	31.051	5/8	88.015	69.127	5/8	158.14	124.20
7/8	39.954	31.380	3/4	89.268	70.111	3/4	159.82	125.52
15/16	40.376	31.711	7/8	90.529	71.102	7/8	161.50	126.85

WEIGHTS OF SQUARE AND ROUND BARS PER RUNNING INCH

ONE CUBIC INCH OF STEEL WEIGHS 0.2833 LBS.

Size or Diameter In.	Weight, Lbs. per In. Square	Weight, Lbs. per In. Round	Size or Diameter In.	Weight, Lbs. per In. Square	Weight, Lbs. per In. Round	Size or Diameter In.	Weight, Lbs. per In. Square	Weight, Lbs. per In. Round
24	163.20	128.18	30	255.00	200.28	36	367.20	288.40
1/8	164.90	129.52	1/8	257.13	201.95	1/8	369.75	290.40
1/4	166.62	130.86	1/4	259.27	203.63	1/4	372.32	292.42
3/8	168.34	132.21	3/8	261.41	205.31	3/8	374.89	294.44
1/2	170.07	133.57	1/2	263.57	207.01	1/2	377.47	296.46
5/8	171.81	134.94	5/8	265.74	208.71	5/8	380.06	298.50
3/4	173.56	136.31	3/4	267.91	210.42	3/4	382.66	300.54
7/8	175.32	137.69	7/8	270.09	212.13	7/8	385.27	302.59
25	177.08	139.08	31	272.28	213.85	37	387.88	304.64
1/8	178.86	140.48	1/8	274.48	215.58	1/8	390.51	306.70
1/4	180.64	141.88	1/4	276.69	217.31	1/4	393.14	308.77
3/8	182.44	143.28	3/8	278.91	219.06	3/8	395.79	310.85
1/2	184.24	144.70	1/2	281.14	220.80	1/2	398.44	312.93
5/8	186.05	146.12	5/8	283.37	222.56	5/8	401.10	315.02
3/4	187.87	147.55	3/4	285.62	224.32	3/4	403.77	317.12
7/8	189.70	148.99	7/8	287.87	226.09	7/8	406.45	319.22
26	191.53	150.43	32	290.13	227.87	38	409.13	321.33
1/8	193.38	151.88	1/8	292.40	229.65	1/8	411.83	323.45
1/4	195.23	153.34	1/4	294.68	231.44	1/4	414.53	325.57
3/8	197.10	154.80	3/8	296.97	233.24	3/8	417.25	327.71
1/2	198.97	156.27	1/2	299.27	235.05	1/2	419.97	329.84
5/8	200.85	157.75	5/8	301.58	236.86	5/8	422.70	331.99
3/4	202.74	159.23	3/4	303.89	238.68	3/4	425.44	334.14
7/8	204.64	160.73	7/8	306.22	240.50	7/8	428.19	336.30
27	206.55	162.22	33	308.55	242.33	39	430.95	338.47
1/8	208.47	163.73	1/8	310.89	244.17	1/8	433.72	340.64
1/4	210.39	165.24	1/4	313.24	246.02	1/4	436.49	342.82
3/8	212.33	166.76	3/8	315.60	247.87	3/8	439.28	345.01
1/2	214.27	168.29	1/2	317.97	249.73	1/2	442.07	347.20
5/8	216.22	169.82	5/8	320.35	251.60	5/8	444.87	349.40
3/4	218.18	171.36	3/4	322.73	253.47	3/4	447.68	351.61
7/8	220.15	172.91	7/8	325.13	255.36	7/8	450.50	353.83
28	222.13	174.46	34	327.53	257.24	40	453.33	356.05
1/8	224.12	176.02	1/8	329.95	259.14	1/8	456.17	358.28
1/4	226.12	177.59	1/4	332.37	261.04	1/4	459.02	360.51
3/8	228.12	179.17	3/8	334.80	262.95	3/8	461.87	362.75
1/2	230.14	180.75	1/2	337.24	264.87	1/2	464.74	365.00
5/8	232.16	182.34	5/8	339.69	266.79	5/8	467.61	367.26
3/4	234.19	183.93	3/4	342.14	268.72	3/4	470.49	369.52
7/8	236.23	185.54	7/8	344.61	270.65	7/8	473.38	371.79
29	238.28	187.15	35	347.08	272.60	41	476.28	374.07
1/8	240.34	188.76	1/8	349.57	274.55	1/8	479.19	376.36
1/4	242.41	190.39	1/4	352.06	276.51	1/4	482.11	378.65
3/8	244.49	192.02	3/8	354.56	278.47	3/8	485.04	380.95
1/2	246.57	193.66	1/2	357.07	280.44	1/2	487.97	383.25
5/8	248.66	195.30	5/8	359.59	282.42	5/8	490.91	385.56
3/4	250.77	196.95	3/4	362.12	284.41	3/4	493.87	387.88
7/8	252.88	198.61	7/8	364.65	286.40	7/8	496.83	390.21

WEIGHTS OF SQUARE AND ROUND BARS PER RUNNING INCH

ONE CUBIC INCH OF STEEL WEIGHS 0.2833 LBS.

Size or Diameter In.	Weight, Lbs. per In.		Size or Diameter In.	Weight, Lbs. per In.		Size or Diameter In.	Weight, Lbs. per In.	
	Square	Round		Square	Round		Square	Round
42	499.80	392.54	48	652.80	512.71	54	826.20	648.90
1/8	502.78	394.88	1/8	656.20	515.38	1/8	830.03	651.90
1/4	505.77	397.23	1/4	659.62	518.06	1/4	833.87	654.92
3/8	508.76	399.58	3/8	663.04	520.75	3/8	837.71	657.94
1/2	511.77	401.94	1/2	666.47	523.44	1/2	841.57	660.97
5/8	514.79	404.31	5/8	669.91	526.15	5/8	845.44	664.00
3/4	517.81	406.69	3/4	673.36	528.86	3/4	849.31	667.05
7/8	520.84	409.07	7/8	676.82	531.57	7/8	853.19	670.10
43	523.88	411.46	49	680.28	534.29	55	857.08	673.15
1/8	526.93	413.85	1/8	683.76	537.02	1/8	860.98	676.21
1/4	529.99	416.26	1/4	687.24	539.76	1/4	864.89	679.29
3/8	533.06	418.66	3/8	690.74	542.50	3/8	868.81	682.36
1/2	536.14	421.08	1/2	694.24	545.25	1/2	872.74	685.45
5/8	539.22	423.50	5/8	697.75	548.01	5/8	876.67	688.54
3/4	542.32	425.94	3/4	701.27	550.77	3/4	880.62	691.64
7/8	545.42	428.37	7/8	704.80	553.55	7/8	884.57	694.74
44	548.53	430.82	50	708.33	556.32	56	888.53	697.85
1/8	551.65	433.27	1/8	711.88	559.11	1/8	892.50	700.97
1/4	554.78	435.73	1/4	715.43	561.90	1/4	896.48	704.10
3/8	557.92	438.19	3/8	719.00	564.70	3/8	900.47	707.23
1/2	561.07	440.66	1/2	722.57	567.51	1/2	904.47	710.37
5/8	564.23	443.14	5/8	726.15	570.32	5/8	908.48	713.52
3/4	567.39	445.63	3/4	729.74	573.14	3/4	912.49	716.67
7/8	570.57	448.12	7/8	733.34	575.97	7/8	916.52	719.83
45	573.75	450.62	51	736.95	578.80	57	920.55	723.00
1/8	576.94	453.13	1/8	740.57	581.64	1/8	924.59	726.17
1/4	580.14	455.64	1/4	744.19	584.49	1/4	928.64	729.35
3/8	583.35	458.16	3/8	747.83	587.34	3/8	932.70	732.54
1/2	586.57	460.69	1/2	751.47	590.20	1/2	936.77	735.74
5/8	589.80	463.23	5/8	755.12	593.07	5/8	940.85	738.94
3/4	593.03	465.77	3/4	758.78	595.95	3/4	944.93	742.15
7/8	596.28	468.32	7/8	762.45	598.83	7/8	949.03	745.37
46	599.53	470.87	52	766.13	601.72	58	953.13	748.59
1/8	602.80	473.43	1/8	769.82	604.62	1/8	957.25	751.82
1/4	606.07	476.00	1/4	773.52	607.52	1/4	961.37	755.06
3/8	609.35	478.58	3/8	777.22	610.43	3/8	965.50	758.30
1/2	612.64	481.16	1/2	780.94	613.35	1/2	969.64	761.55
5/8	615.94	483.75	5/8	784.66	616.27	5/8	973.79	764.81
3/4	619.24	486.35	3/4	788.39	619.20	3/4	977.94	768.07
7/8	622.56	488.96	7/8	792.13	622.14	7/8	982.11	771.35
47	625.88	491.57	53	795.88	625.09	59	986.28	774.63
1/8	629.22	494.19	1/8	799.64	628.04	1/8	990.47	777.91
1/4	632.56	496.81	1/4	803.41	631.00	1/4	994.66	781.20
3/8	635.91	499.44	3/8	807.19	633.96	3/8	998.86	784.50
1/2	639.27	502.08	1/2	810.97	636.94	1/2	1003.1	787.81
5/8	642.64	504.73	5/8	814.76	639.91	5/8	1007.3	791.12
3/4	646.02	507.38	3/4	818.57	642.90	3/4	1011.5	794.44
7/8	649.40	510.04	7/8	822.38	645.90	7/8	1015.8	797.77

$\frac{3}{8}$—$\frac{21}{32}$
$\frac{1}{32}$—$2\frac{1}{4}$

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches									
	3/8	13/32	7/16	15/32	1/2	17/32	9/16	19/32	5/8	21/32
1/32	.0398	.0432	.0465	.0498	.0531	.0564	.0598	.0631	.0664	.0697
1/16	.0797	.0863	.0930	.0996	.1063	.1129	.1195	.1262	.1328	.1395
3/32	.1195	.1295	.1395	.1494	.1594	.1693	.1793	.1893	.1992	.2092
1/8	.1594	.1727	.1859	.1992	.2125	.2258	.2391	.2523	.2656	.2789
5/32	.1992	.2158	.2324	.2490	.2656	.2822	.2988	.3154	.3320	.3486
3/16	.2391	.2590	.2789	.2988	.3188	.3387	.3586	.3785	.3984	.4184
7/32	.2789	.3021	.3254	.3486	.3719	.3951	.4184	.4416	.4648	.4881
1/4	.3188	.3453	.3719	.3984	.4250	.4516	.4781	.5047	.5313	.5578
5/16	.3984	.4316	.4648	.4980	.5313	.5645	.5977	.6309	.6641	.6973
3/8	.4781	.5180	.5578	.5977	.6375	.6773	.7172	.7570	.7969	.8367
7/16	.5578	.6043	.6508	.6973	.7438	.7902	.8367	.8832	.9297	.9762
1/2	.6375	.6906	.7438	.7969	.8500	.9031	.9563	1.0094	1.0625	1.1156
9/16	.7172	.7770	.8367	.8965	.9563	1.0160	1.0758	1.1355	1.1953	1.2551
5/8	.7969	.8633	.9297	.9961	1.0625	1.1289	1.1953	1.2617	1.3281	1.3945
11/16	.8766	.9496	1.0227	1.0957	1.1688	1.2418	1.3148	1.3879	1.4609	1.5340
3/4	.9563	1.0359	1.1156	1.1953	1.2750	1.3547	1.4344	1.5141	1.5938	1.6734
13/16	1.0359	1.1223	1.2086	1.2949	1.3813	1.4676	1.5539	1.6402	1.7266	1.8129
7/8	1.1156	1.2086	1.3016	1.3945	1.4875	1.5805	1.6734	1.7664	1.8594	1.9523
15/16	1.1953	1.2949	1.3945	1.4941	1.5938	1.6934	1.7930	1.8926	1.9922	2.0918
1	1.2750	1.3813	1.4875	1.5938	1.7000	1.8063	1.9125	2.0188	2.1250	2.2313
1/8	1.4344	1.5539	1.6734	1.7930	1.9125	2.0320	2.1516	2.2711	2.3906	2.5102
1/4	1.5938	1.7266	1.8594	1.9922	2.1250	2.2578	2.3906	2.5234	2.6563	2.7891
3/8	1.7531	1.8992	2.0453	2.1914	2.3375	2.4836	2.6297	2.7758	2.9219	3.0680
1/2	1.9125	2.0719	2.2313	2.3906	2.5500	2.7094	2.8688	3.0281	3.1875	3.3469
5/8	2.0719	2.2445	2.4172	2.5898	2.7625	2.9352	3.1078	3.2805	3.4531	3.6258
3/4	2.2313	2.4172	2.6031	2.7891	2.9750	3.1609	3.3469	3.5328	3.7188	3.9047
7/8	2.3906	2.5898	2.7891	2.9883	3.1875	3.3867	3.5859	3.7852	3.9844	4.1836
2	2.5500	2.7625	2.9750	3.1875	3.4000	3.6125	3.8250	4.0375	4.2500	4.4625
1/8	2.7094	2.9352	3.1609	3.3867	3.6125	3.8383	4.0641	4.2898	4.5156	4.7414
1/4	2 8688	3.1078	3.3469	3.5859	3.8250	4.0641	4.3031	4.5422	4.7813	5.0203

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thick-ness, Inches	Width, Inches									
	11/16	23/32	3/4	25/32	13/16	27/32	7/8	29/32	15/16	31/32
1/32	.0730	.0764	.0797	.0830	.0863	.0896	.0930	.0963	.0996	.1029
1/16	.1461	.1527	.1594	.1660	.1727	.1793	.1859	.1926	.1992	.2059
3/32	.2191	.2291	.2391	.2490	.2590	.2689	.2789	.2889	.2988	.3088
1/8	.2922	.3055	.3188	.3320	.3453	.3586	.3719	.3852	.3984	.4117
5/32	.3652	.3818	.3984	.4150	.4316	.4482	.4648	.4814	.4980	.5146
3/16	.4383	.4582	.4781	.4980	.5180	.5379	.5578	.5777	.5977	.6176
7/32	.5113	.5346	.5578	.5811	.6043	.6275	.6508	.6740	.6973	.7205
1/4	.5844	.6109	.6375	.6641	.6906	.7172	.7438	.7703	.7969	.8234
5/16	.7305	.7637	.7969	.8301	.8633	.8965	.9297	.9629	.9961	1.0293
3/8	.8766	.9164	.9563	.9961	1.0359	1.0758	1.1156	1.1555	1.1953	1.2352
7/16	1.0227	1.0691	1.1156	1.1621	1.2086	1.2551	1.3016	1.3480	1.3945	1.4410
1/2	1.1688	1.2219	1.2750	1.3281	1.3813	1.4344	1.4875	1.5406	1.5938	1.6469
9/16	1.3148	1.3746	1.4344	1.4941	1.5539	1.6137	1.6734	1.7332	1.7930	1.8527
5/8	1.4609	1.5273	1.5938	1.6602	1.7266	1.7930	1.8594	1.9258	1.9922	2.0586
11/16	1.6070	1.6801	1.7531	1.8262	1.8992	1.9723	2.0453	2.1184	2.1914	2.2645
3/4	1.7531	1.8328	1.9125	1.9922	2.0719	2.1516	2.2313	2.3109	2.3906	2.4703
13/16	1.8992	1.9855	2.0719	2.1582	2.2445	2.3309	2.4172	2.5035	2.5898	2.6762
7/8	2.0453	2.1383	2.2313	2.3242	2.4172	2.5102	2.6031	2.6961	2.7891	2.8820
15/16	2.1914	2.2910	2.3906	2.4902	2.5898	2.6895	2.7891	2.8887	2.9883	3.0879
1	2.3375	2.4438	2.5500	2.6563	2.7625	2.8688	2.9750	3.0813	3.1875	3.2938
1/8	2.6297	2.7492	2.8688	2.9883	3.1078	3.2273	3.3469	3.4664	3.5859	3.7055
1/4	2.9219	3.0547	3.1875	3.3203	3.4531	3.5859	3.7188	3.8516	3.9844	4.1172
3/8	3.2141	3.3602	3.5063	3.6523	3.7984	3.9445	4.0906	4.2367	4.3828	4.5289
1/2	3.5063	3.6656	3.8250	3.9844	4.1438	4.3031	4.4625	4.6219	4.7813	4.9406
5/8	3.7984	3.9711	4.1438	4.3164	4.4891	4.6617	4.8344	5.0070	5.1797	5.3523
3/4	4.0906	4.2766	4.4625	4.6484	4.8344	5.0203	5.2063	5.3922	5.5781	5.7641
7/8	4.3828	4.5820	4.7813	4.9805	5.1797	5.3789	5.5781	5.7773	5.9766	6.1758
2	4.6750	4.8875	5.1000	5.3125	5.5250	5.7375	5.9500	6.1625	6.3750	6.5875
1/8	4.9672	5.1930	5.4188	5.6445	5.8703	6.0961	6.3219	6.5477	6.7734	6.9992
1/4	5.2594	5.4984	5.7375	5.9766	6.2156	6.4547	6.6938	6.9328	7.1719	7.4109

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches									
	1	1 1/32	1 1/16	1 3/32	1 1/8	1 5/32	1 3/16	1 7/32	1 1/4	1 9/32
1/32	.1063	.1096	.1129	.1162	.1195	.1229	.1262	.1295	.1328	.1361
1/16	.2125	.2191	.2258	.2324	.2391	.2457	.2523	.2590	.2656	.2723
3/32	.3188	.3287	.3387	.3486	.3586	.3686	.3785	.3885	.3984	.4084
1/8	.4250	.4383	.4516	.4648	.4781	.4914	.5047	.5180	.5313	.5445
5/32	.5313	.5479	.5645	.5811	.5977	.6143	.6309	.6475	.6641	.6807
3/16	.6375	.6574	.6773	.6973	.7172	.7371	.7570	.7770	.7969	.8168
7/32	.7438	.7670	.7902	.8135	.8367	.8600	.8832	.9064	.9297	.9529
1/4	.8500	.8766	.9031	.9297	.9563	.9828	1.0094	1.0359	1.0625	1.0891
5/16	1.0625	1.0957	1.1289	1.1621	1.1953	1.2285	1.2617	1.2949	1.3281	1.3613
3/8	1.2750	1.3148	1.3547	1.3945	1.4344	1.4742	1.5141	1.5539	1.5938	1.6336
7/16	1.4875	1.5340	1.5805	1.6270	1.6734	1.7199	1.7664	1.8129	1.8594	1.9059
1/2	1.7000	1.7531	1.8063	1.8594	1.9125	1.9656	2.0188	2.0719	2.1250	2.1781
9/16	1.9125	1.9723	2.0320	2.0918	2.1516	2.2113	2.2711	2.3309	2.3906	2.4504
5/8	2.1250	2.1914	2.2578	2.3242	2.3906	2.4570	2.5234	2.5898	2.6563	2.7227
11/16	2.3375	2.4105	2.4836	2.5566	2.6297	2.7027	2.7758	2.8488	2.9219	2.9949
3/4	2.5500	2.6297	2.7094	2.7891	2.8688	2.9484	3.0281	3.1078	3.1875	3.2672
13/16	2.7625	2.8488	2.9352	3.0215	3.1078	3.1941	3.2805	3.3668	3.4531	3.5395
7/8	2.9750	3.0680	3.1609	3.2539	3.3469	3.4398	3.5328	3.6258	3.7188	3.8117
15/16	3.1875	3.2871	3.3867	3.4863	3.5859	3.6855	3.7852	3.8848	3.9844	4.0840
1	3.4000	3.5063	3.6125	3.7188	3.8250	3.9313	4.0375	4.1438	4.2500	4.3563
1/8	3.8250	3.9445	4.0641	4.1836	4.3031	4.4227	4.5422	4.6617	4.7813	4.9008
1/4	4.2500	4.3828	4.5156	4.6484	4.7813	4.9141	5.0469	5.1797	5.3125	5.4453
3/8	4.6750	4.8211	4.9672	5.1133	5.2594	5.4055	5.5516	5.6977	5.8438	5.9898
1/2	5.1000	5.2594	5.4188	5.5781	5.7375	5.8969	6.0563	6.2156	6.3750	6.5344
5/8	5.5250	5.6977	5.8703	6.0430	6.2156	6.3883	6.5609	6.7336	6.9063	7.0789
3/4	5.9500	6.1359	6.3219	6.5078	6.6938	6.8797	7.0656	7.2516	7.4375	7.6234
7/8	6.3750	6.5742	6.7734	6.9727	7.1719	7.3711	7.5703	7.7695	7.9688	8.1680
2	6.8000	7.0125	7.2250	7.4375	7.6500	7.8625	8.0750	8.2875	8.5000	8.7125
1/8	7.2250	7.4508	7.6766	7.9023	8.1281	8.3539	8.5797	8.8055	9.0313	9.2570
1/4	7.6500	7.8891	8.1281	8.3672	8.6063	8.8453	9.0844	9.3234	9.5625	9.8016

1 5/16—1 11/16
1/32—2 1/4

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches									
	1 5/16	1 11/32	1 3/8	1 13/32	1 7/16	1 15/32	1 1/2	1 9/16	1 5/8	1 11/16
1/32	.139	.143	.146	.149	.153	.156	.159	.166	.173	.179
1/16	.279	.286	.292	.299	.305	.312	.319	.332	.345	.359
3/32	.418	.428	.438	.448	.458	.468	.478	.498	.518	.538
1/8	.558	.571	.584	.598	.611	.624	.638	.664	.691	.717
5/32	.697	.714	.730	.747	.764	.780	.797	.830	863	.896
3/16	.837	.857	.877	.896	.916	.936	.956	.996	1.036	1.076
7/32	.976	.999	1.023	1.046	1.069	1.092	1.116	1.162	1.209	1.255
1/4	1.116	1.142	1.169	1.195	1.222	1.248	1.275	1.328	1.381	1.434
5/16	1.395	1.428	1.461	1.494	1.527	1.561	1.594	1.660	1.727	1.793
3/8	1.673	1.713	1.753	1.793	1.833	1.873	1.913	1.992	2.072	2.152
7/16	1.952	1.999	2.045	2.092	2.138	2.185	2.231	2.324	2.417	2.510
1/2	2.231	2.284	2.338	2.391	2.444	2.497	2.550	2.656	2.763	2.869
9/16	2.510	2.570	2.630	2.689	2.749	2.809	2.869	2.988	3.108	3.227
5/8	2.789	2.855	2.922	2.988	3.055	3.121	3.188	3.320	3.453	3.586
11/16	3.068	3.141	3.214	3.287	3.360	3.433	3.506	3.652	3.798	3.945
3/4	3.347	3.427	3.506	3.586	3.666	3.745	3.825	3.984	4.144	4.303
13/16	3.626	3.712	3.798	3.885	3.971	4.057	4.144	4.316	4.489	4.662
7/8	3.905	3.998	4.091	4.184	4.277	4.370	4.463	4.648	4.834	5.020
15/16	4.184	4.283	4.383	4.482	4.582	4.682	4.781	4.980	5.180	5.379
1	4.463	4.569	4.675	4.781	4.888	4.994	5.100	5.313	5.525	5.738
1/8	5.020	5.140	5.259	5.379	5.498	5.618	5.738	5.977	6.216	6.455
1/4	5.578	5.711	5.844	5.977	6.109	6.242	6.375	6.641	6.906	7.172
3/8	6.136	6.282	6.428	6.574	6.720	6.866	7.013	7.305	7.597	7.889
1/2	6.694	6.853	7.013	7.172	7.331	7.491	7.650	7.969	8.288	8.606
5/8	7.252	7.424	7.597	7.770	7.942	8.115	8.288	8.633	8.978	9.323
3/4	7.809	7.995	8.181	8.367	8.553	8.739	8.925	9.297	9.669	10.041
7/8	8.367	8.566	8.766	8.965	9.164	9.363	9.563	9.961	10.359	10.758
2	8.925	9.138	9.350	9.563	9.775	9.988	10.200	10.625	11.050	11.475
1/8	9.483	9.709	9.934	10.160	10.386	10.612	10.838	11.289	11.741	12.192
1/4	10.041	10.280	10.519	10.758	10.997	11.236	11.475	11.953	12.431	12.909

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches									
	1¾	1$^{13}/_{16}$	1⅞	1$^{15}/_{16}$	2	2$^{1}/_{16}$	2⅛	2$^{3}/_{16}$	2¼	2$^{5}/_{16}$
$^{1}/_{32}$	.186	.193	.199	.206	.213	.219	.226	.232	.239	.246
$^{1}/_{16}$	.372	.385	.398	.412	.425	.438	.452	.465	.478	.491
$^{3}/_{32}$	.558	.578	.598	.618	.638	.657	.677	.697	.717	.737
⅛	.744	.770	.797	.823	.850	.877	.903	.930	.956	.983
$^{5}/_{32}$	.930	.963	.996	1.029	1.063	1.096	1.129	1.162	1.195	1.229
$^{3}/_{16}$	1.116	1.155	1.195	1.235	1.275	1.315	1.355	1.395	1.434	1.474
$^{7}/_{32}$	1.302	1.348	1.395	1.441	1.488	1.534	1.580	1.627	1.673	1.720
¼	1.488	1.541	1.594	1.647	1.700	1.753	1.806	1.859	1.913	1.966
$^{5}/_{16}$	1.859	1.926	1.992	2.059	2.125	2.191	2.258	2.324	2.391	2.457
⅜	2.231	2.311	2.391	2.470	2.550	2.630	2.709	2.789	2.869	2.948
$^{7}/_{16}$	2.603	2.696	2.789	2.882	2.975	3.068	3.161	3.254	3.347	3.440
½	2.975	3.081	3.188	3.294	3.400	3.506	3.613	3.719	3.825	3.931
$^{9}/_{16}$	3.347	3.466	3.586	3.705	3.825	3.945	4.064	4.184	4.303	4.423
⅝	3.719	3.852	3.984	4.117	4.250	4.383	4.516	4.648	4.781	4.914
$^{11}/_{16}$	4.091	4.237	4.383	4.529	4.675	4.821	4.967	5.113	5.259	5.405
¾	4.463	4.622	4.781	4.941	5.100	5.259	5.419	5.578	5.738	5.897
$^{13}/_{16}$	4.834	5.007	5.180	5.352	5.525	5.698	5.870	6.043	6.216	6.388
⅞	5.206	5.392	5.578	5.764	5.950	6.136	6.322	6.508	6.694	6.880
$^{15}/_{16}$	5.578	5.777	5.977	6.176	6.375	6.574	6.773	6.973	7.172	7.371
1	5.950	6.163	6.375	6.588	6.800	7.013	7.225	7.438	7.650	7.863
⅛	6.694	6.933	7.172	7.411	7.650	7.889	8.128	8.367	8.606	8.845
¼	7.438	7.703	7.969	8.234	8.500	8.766	9.031	9.297	9.563	9.828
⅜	8.181	8.473	8.766	9.058	9.350	9.642	9.934	10.227	10.519	10.811
½	8.925	9.244	9.563	9.881	10.200	10.519	10.838	11.156	11.475	11.794
⅝	9.669	10.014	10.359	10.705	11.050	11.395	11.741	12.086	12.431	12.777
¾	10.413	10.784	11.156	11.528	11.900	12.272	12.644	13.016	13.388	13.759
⅞	11.156	11.555	11.953	12.352	12.750	13.148	13.547	13.945	14.344	14.742
2	11.900	12.325	12.750	13.175	13.600	14.025	14.450	14.875	15.300	15.725
⅛	12.644	13.095	13.547	13.998	14.450	14.902	15.353	15.805	16.256	16.708
¼	13.388	13.866	14.344	14.822	15.300	15.778	16.256	16.734	17.213	17.691

$2\frac{3}{8}$—$2\frac{15}{16}$
$\frac{1}{32}$—$2\frac{1}{4}$

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches									
	2 3/8	2 7/16	2 1/2	2 9/16	2 5/8	2 11/16	2 3/4	2 13/16	2 7/8	2 15/16
1/32	.252	.259	.266	.272	.279	.286	.292	.299	.305	.312
1/16	.505	.518	.531	.545	.558	.571	.584	.598	.611	.624
3/32	.757	.777	.797	.817	.837	.857	.877	.896	.916	.936
1/8	1.009	1.036	1.063	1.089	1.116	1.142	1.169	1.195	1.222	1.248
5/32	1.262	1.295	1.328	1.361	1.395	1.428	1.461	1.494	1.527	1.561
3/16	1.514	1.554	1.594	1.634	1.673	1.713	1.753	1.793	1.833	1.873
7/32	1.766	1.813	1.859	1.906	1.952	1.999	2.045	2.092	2.138	2.185
1/4	2.019	2.072	2.125	2.178	2.231	2.284	2.338	2.391	2.444	2.497
5/16	2.523	2.590	2.656	2.723	2.789	2.855	2.922	2.988	3.055	3.121
3/8	3.028	3.108	3.188	3.267	3.347	3.427	3.506	3.586	3.666	3.745
7/16	3.533	3.626	3.719	3.812	3.905	3.998	4.091	4.184	4.277	4.370
1/2	4.038	4.144	4.250	4.356	4.463	4.569	4.675	4.781	4.888	4.994
9/16	4.542	4.662	4.781	4.901	5.020	5.140	5.259	5.379	5.498	5.618
5/8	5.047	5.180	5.313	5.445	5.578	5.711	5.844	5.977	6.109	6.242
11/16	5.552	5.698	5.844	5.990	6.136	6.282	6.428	6.574	6.720	6.866
3/4	6.056	6.216	6.375	6.534	6.694	6.853	7.013	7.172	7.331	7.491
13/16	6.561	6.734	6.906	7.079	7.252	7.424	7.597	7.770	7.942	8.115
7/8	7.066	7.252	7.438	7.623	7.809	7.995	8.181	8.367	8.553	8.739
15/16	7.570	7.770	7.969	8.168	8.367	8.566	8.766	8.965	9.164	9.363
1	8.075	8.288	8.500	8.713	8.925	9.138	9.350	9.563	9.775	9.988
1/8	9.084	9.323	9.563	9.802	10.041	10.280	10.519	10.758	10.997	11.236
1/4	10.094	10.359	10.625	10.891	11.156	11.422	11.688	11.953	12.219	12.484
3/8	11.103	11.395	11.688	11.980	12.272	12.564	12.856	13.148	13.441	13.733
1/2	12.113	12.431	12.750	13.069	13.388	13.706	14.025	14.344	14.663	14.981
5/8	13.122	13.467	13.813	14.158	14.503	14.848	15.194	15.539	15.884	16.230
3/4	14.131	14.503	14.875	15.247	15.619	15.991	16.363	16.734	17.106	17.478
7/8	15.141	15.539	15.938	16.336	16.734	17.133	17.531	17.930	18.328	18.727
2	16.150	16.575	17.000	17.425	17.850	18.275	18.700	19.125	19.550	19.975
1/8	17.159	17.611	18.063	18.514	18.966	19.417	19.869	20.320	20.772	21.223
1/4	18.169	18.647	19.125	19.603	20.081	20.559	21.038	21.516	21.994	22.472

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches									
	3	3 1/16	3 1/8	3 3/16	3 1/4	3 5/16	3 3/8	3 7/16	3 1/2	3 9/16
1/32	.319	.325	.332	.339	.345	.352	.359	.365	.372	.379
1/16	.638	.651	.664	.677	.691	.704	.717	.730	.744	.757
3/32	.956	.976	.996	1.016	1.036	1.056	1.076	1.096	1.116	1.136
1/8	1.275	1.302	1.328	1.355	1.381	1.408	1.434	1.461	1.488	1.514
5/32	1.594	1.627	1.660	1.693	1.727	1.760	1.793	1.826	1.859	1.893
3/16	1.913	1.952	1.992	2.032	2.072	2.112	2.152	2.191	2.231	2.271
7/32	2.231	2.278	2.324	2.371	2.417	2.464	2.510	2.557	2.603	2.650
1/4	2.550	2.603	2.656	2.709	2.763	2.816	2.869	2.922	2.975	3.028
5/16	3.188	3.254	3.320	3.387	3.453	3.520	3.586	3.652	3.719	3.785
3/8	3.825	3.905	3.984	4.064	4.144	4.223	4.303	4.383	4.463	4.542
7/16	4.463	4.555	4.648	4.741	4.834	4.927	5.020	5.113	5.206	5.299
1/2	5.100	5.206	5.313	5.419	5.525	5.631	5.738	5.844	5.950	6.056
9/16	5.738	5.857	5.977	6.096	6.216	6.335	6.455	6.574	6.694	6.813
5/8	6.375	6.508	6.641	6.773	6.906	7.039	7.172	7.305	7.438	7.570
11/16	7.013	7.159	7.305	7.451	7.597	7.743	7.889	8.035	8.181	8.327
3/4	7.650	7.809	7.969	8.128	8.288	8.447	8.606	8.766	8.925	9.084
13/16	8.288	8.460	8.633	8.805	8.978	9.151	9.323	9.496	9.669	9.841
7/8	8.925	9.111	9.297	9.483	9.669	9.855	10.041	10.227	10.413	10.598
15/16	9.563	9.762	9.961	10.160	10.359	10.559	10.758	10.957	11.156	11.355
1	10.200	10.413	10.625	10.838	11.050	11.263	11.475	11.688	11.900	12.113
1/8	11.475	11.714	11.953	12.192	12.431	12.670	12.909	13.148	13.388	13.627
1/4	12.750	13.016	13.281	13.547	13.813	14.078	14.344	14.609	14.875	15.141
3/8	14.025	14.317	14.609	14.902	15.194	15.486	15.778	16.070	16.363	16.655
1/2	15.300	15.619	15.938	16.256	16.575	16.894	17.213	17.531	17.850	18.169
5/8	16.575	16.920	17.266	17.611	17.956	18.302	18.647	18.992	19.338	19.683
3/4	17.850	18.222	18.594	18.966	19.338	19.709	20.081	20.453	20.825	21.197
7/8	19.125	19.523	19.922	20.320	20.719	21.117	21.516	21.914	22.313	22.711
2	20.400	20.825	21.250	21.675	22.100	22.525	22.950	23.375	23.800	24.225
1/8	21.675	22.127	22.578	23.030	23.481	23.933	24.384	24.836	25.288	25.739
1/4	22.950	23.428	23.906	24.384	24.863	25.341	25.819	26.297	26.775	27.253

$3\frac{5}{8}$—$4\frac{3}{16}$
$\frac{1}{32}$—$2\frac{1}{4}$

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches									
	3 5/8	3 11/16	3 3/4	3 13/16	3 7/8	3 15/16	4	4 1/16	4 1/8	4 3/16
1/32	.385	.392	.398	.405	.412	.418	.425	.432	.438	.445
1/16	.770	.784	.797	.810	.823	.837	.850	.863	.877	.890
3/32	1.155	1.175	1.195	1.215	1.235	1.255	1.275	1.295	1.315	1.335
1/8	1.541	1.567	1.594	1.620	1.647	1.673	1.700	1.727	1.753	1.780
5/32	1.926	1.959	1.992	2.025	2.059	2.092	2.125	2.158	2.191	2.225
3/16	2.311	2.351	2 391	2.430	2.470	2.510	2.550	2.590	2.630	2.670
7/32	2.696	2.743	2.789	2.836	2.882	2.929	2.975	3.021	3.068	3.114
1/4	3.081	3.134	3.188	3.241	3.294	3.347	3.400	3.453	3.506	3.559
5/16	3.852	3.918	3.984	4.051	4.117	4.184	4.250	4.316	4.383	4.449
3/8	4.622	4.702	4.781	4.861	4.941	5.020	5.100	5.180	5.259	5.339
7/16	5.392	5.485	5.578	5.671	5.764	5.857	5.950	6.043	6.136	6.229
1/2	6.163	6.269	6.375	6.481	6.588	6.694	6.800	6.906	7.013	7.119
9/16	6.933	7.052	7.172	7.291	7.411	7.530	7.650	7.770	7.889	8.009
5/8	7.703	7.836	7.969	8.102	8.234	8.367	8.500	8.633	8.766	8.898
11/16	8.473	8.620	8.766	8.912	9.058	9.204	9.350	9.496	9.642	9.788
3/4	9.244	9.403	9.563	9.722	9.881	10.041	10.200	10.359	10.519	10.678
13/16	10.014	10.187	10.359	10.532	10.705	10.877	11.050	11.223	11.395	11.568
7/8	10.784	10.970	11.156	11.342	11.528	11.714	11.900	12.086	12.272	12.458
15/16	11.555	11.754	11.953	12.152	12.352	12.551	12.750	12.949	13.148	13.348
1	12.325	12.538	12.750	12.963	13.175	13.388	13.600	13.813	14.025	14.238
1/8	13.866	14.105	14.344	14.583	14.822	15.061	15.300	15.539	15.778	16.017
1/4	15.406	15.672	15.938	16.203	16.469	16.734	17.000	17.266	17.531	17.797
3/8	16.947	17.239	17.531	17.823	18.116	18.408	18.700	18.992	19.284	19.577
1/2	18.488	18.806	19.125	19.444	19.763	20.081	20.400	20.719	21.038	21.356
5/8	20.028	20.373	20.719	21.064	21.409	21.755	22.100	22.445	22.791	23.136
3/4	21.569	21.941	22.313	22.684	23.056	23.428	23.800	24.172	24.544	24.916
7/8	23.109	23.508	23.906	24.305	24.703	25.102	25.500	25.898	26.297	26.695
2	24.650	25.075	25.500	25.925	26.350	26.775	27.200	27.625	28.050	28.475
1/8	26.191	26.642	27.094	27.545	27.997	28.448	28.900	29.352	29.803	30.255
1/4	27.731	28.209	28.688	29.166	29.644	30.122	30.600	31.078	31.556	32.034

$4\frac{1}{4}$—$4\frac{7}{8}$
$\frac{1}{32}$—$2\frac{1}{4}$

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches									
	4¼	4⁵⁄₁₆	4⅜	4⁷⁄₁₆	4½	4⁹⁄₁₆	4⅝	4¹¹⁄₁₆	4¾	4⅞
¹⁄₃₂	.452	.458	.465	.471	.478	.485	.491	.498	.505	.518
¹⁄₁₆	.903	.916	.930	.943	.956	.970	.983	.996	1.009	1.036
³⁄₃₂	1.355	1.375	1.395	1.414	1.434	1.454	1.474	1.494	1.514	1.554
⅛	1.806	1.833	1.859	1.886	1.913	1.939	1.966	1.992	2.019	2.072
⁵⁄₃₂	2.258	2.291	2.324	2.357	2.391	2.424	2.457	2.490	2.523	2.590
³⁄₁₆	2.709	2.749	2.789	2.829	2.869	2.909	2.948	2.988	3.028	3.108
⁷⁄₃₂	3.161	3.207	3.254	3.300	3.347	3.393	3.440	3.486	3.533	3.626
¼	3.613	3.666	3.719	3.772	3.825	3.878	3.931	3.984	4.038	4.144
⁵⁄₁₆	4.516	4.582	4.648	4.715	4.781	4.848	4.914	4.980	5.047	5.180
⅜	5.419	5.498	5.578	5.658	5.738	5.817	5.897	5.977	6.056	6.216
⁷⁄₁₆	6.322	6.415	6.508	6.601	6.694	6.787	6.880	6.973	7.066	7.252
½	7.225	7.331	7.438	7.544	7.650	7.756	7.863	7.969	8.075	8.288
⁹⁄₁₆	8.128	8.248	8.367	8.487	8.606	8.726	8.845	8.965	9.084	9.323
⅝	9.031	9.164	9.297	9.430	9.563	9.695	9.828	9.961	10.094	10.359
¹¹⁄₁₆	9.934	10.080	10.227	10.373	10.519	10.665	10.811	10.957	11.103	11.395
¾	10.838	10.997	11.156	11.316	11.475	11.634	11.794	11.953	12.113	12.431
¹³⁄₁₆	11.741	11.913	12.086	12.259	12.431	12.604	12.777	12.949	13.122	13.467
⅞	12.644	12.830	13.016	13.202	13.388	13.573	13.759	13.945	14.131	14.503
¹⁵⁄₁₆	13.547	13.746	13.945	14.145	14.344	14.543	14.742	14.941	15.141	15.539
1	14.450	14.663	14.875	15.088	15.300	15.513	15.725	15.938	16.150	16.575
⅛	16.256	16.495	16.734	16.973	17.213	17.452	17.691	17.930	18.169	18.647
¼	18.063	18.328	18.594	18.859	19.125	19.391	19.656	19.922	20.188	20.719
⅜	19.869	20.161	20.453	20.745	21.038	21.330	21.622	21.914	22.206	22.791
½	21.675	21.994	22.313	22.631	22.950	23.269	23.588	23.906	24.225	24.863
⅝	23.481	23.827	24.172	24.517	24.863	25.208	25.553	25.898	26.244	26.934
¾	25.288	25.659	26.031	26.403	26.775	27.147	27.519	27.891	28.263	29.006
⅞	27.094	27.492	27.891	28.289	28.688	29.086	29.484	29.883	30.281	31.078
2	28.900	29.325	29.750	30.175	30.600	31.025	31.450	31.875	32.300	33.150
⅛	30.706	31.158	31.609	32.061	32.513	32.964	33.416	33.867	34.319	35.222
¼	32.513	32.991	33.469	33.947	34.425	34.903	35.381	35.859	36.338	37.294

5—6⅛
1/32—2¼

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches									
	5	5⅛	5¼	5⅜	5½	5⅝	5¾	5⅞	6	6⅛
1/32	.531	.545	.558	.571	.584	.598	.611	.624	.638	.651
1/16	1.063	1.089	1.116	1.142	1.169	1.195	1.222	1.248	1.275	1.302
3/32	1.594	1.634	1.673	1.713	1.753	1.793	1.833	1.873	1.913	1.952
1/8	2.125	2.178	2.231	2.284	2.338	2.391	2.444	2.497	2.550	2.603
5/32	2.656	2.723	2.789	2.855	2.922	2.988	3.055	3.121	3.188	3.254
3/16	3.188	3.267	3.347	3.427	3.506	3.586	3.666	3.745	3.825	3.905
7/32	3.719	3.812	3.905	3.998	4.091	4.184	4.277	4.370	4.463	4.555
1/4	4.250	4.356	4.463	4.569	4.675	4.781	4.888	4.994	5.100	5.206
5/16	5.313	5.445	5.578	5.711	5.844	5.977	6.109	6.242	6.375	6.508
3/8	6.375	6.534	6.694	6.853	7.013	7.172	7.331	7.491	7.650	7.809
7/16	7.438	7.623	7.809	7.995	8.181	8.367	8.553	8.739	8.925	9.111
1/2	8.500	8.713	8.925	9.138	9.350	9.563	9.775	9.988	10.200	10.413
9/16	9.563	9.802	10.041	10.280	10.519	10.758	10.997	11.236	11.475	11.714
5/8	10.625	10.891	11.156	11.422	11.688	11.953	12.219	12.484	12.750	13.016
11/16	11.688	11.980	12.272	12.564	12.856	13.148	13.441	13.733	14.025	14.317
3/4	12.750	13.069	13.388	13.706	14.025	14.344	14.663	14.981	15.300	15.619
13/16	13.813	14.158	14.503	14.848	15.194	15.539	15.884	16.230	16.575	16.920
7/8	14.875	15.247	15.619	15.991	16.363	16.734	17.106	17.478	17.850	18.222
15/16	15.938	16.336	16.734	17.133	17.531	17.930	18.328	18.727	19.125	19.523
1	17.000	17.425	17.850	18.275	18.700	19.125	19.550	19.975	20.400	20.825
1/8	19.125	19.603	20.081	20.559	21.038	21.516	21.994	22.472	22.950	23.428
1/4	21.250	21.781	22.313	22.844	23.375	23.906	24.438	24.969	25.500	26.031
3/8	23.375	23.959	24.544	25.128	25.713	26.297	26.881	27.466	28.050	28.634
1/2	25.500	26.138	26.775	27.413	28.050	28.688	29.325	29.963	30.600	31.238
5/8	27.625	28.316	29.006	29.697	30.388	31.078	31.769	32.459	33.150	33.841
3/4	29.750	30.494	31.238	31.981	32.725	33.469	34.213	34.956	35.700	36.444
7/8	31.875	32.672	33.469	34.266	35.063	35.859	36.656	37.453	38.250	39.047
2	34.000	34.850	35.700	36.550	37.400	38.250	39.100	39.950	40.800	41.650
1/8	36.125	37.028	37.931	38.834	39.738	40.641	41.544	42.447	43.350	44.253
1/4	38.250	39.206	40.163	41.119	42.075	43.031	43.988	44.944	45.900	46.856

$6\frac{1}{4}$—$7\frac{3}{8}$
$\frac{1}{32}$—$2\frac{1}{4}$

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches									
	6¼	6⅜	6½	6⅝	6¾	6⅞	7	7⅛	7¼	7⅜
1/32	.664	.677	.691	.704	.717	.730	.744	.757	.770	.784
1/16	1.328	1.355	1.381	1.408	1.434	1.461	1.488	1.514	1.541	1.567
3/32	1.992	2.032	2.072	2.112	2.152	2.191	2.231	2.271	2.311	2.351
⅛	2.656	2.709	2.763	2.816	2.869	2.922	2.975	3.028	3.081	3.134
5/32	3.320	3.387	3.453	3.520	3.586	3.652	3.719	3.785	3.852	3.918
3/16	3.984	4.064	4.144	4.223	4.303	4.383	4.463	4.542	4.622	4.702
7/32	4.648	4.741	4.834	4.927	5.020	5.113	5.206	5.299	5.392	5.485
¼	5.313	5.419	5.525	5.631	5.738	5.844	5.950	6.056	6.163	6.269
5/16	6.641	6.773	6.906	7.039	7.172	7.305	7.438	7.570	7.703	7.836
⅜	7.969	8.128	8.288	8.447	8.606	8.766	8.925	9.084	9.244	9.403
7/16	9.297	9.483	9.669	9.855	10.041	10.227	10.413	10.598	10.784	10.970
½	10.625	10.838	11.050	11.263	11.475	11.688	11.900	12.113	12.325	12.538
9/16	11.953	12.192	12.431	12.670	12.909	13.148	13.388	13.627	13.866	14.105
⅝	13.281	13.547	13.813	14.078	14.344	14.609	14.875	15.141	15.406	15.672
11/16	14.609	14.902	15.194	15.486	15.778	16.070	16.363	16.655	16.947	17.239
¾	15.938	16.256	16.575	16.894	17.213	17.531	17.850	18.169	18.488	18.806
13/16	17.266	17.611	17.956	18.302	18.647	18.992	19.338	19.683	20.028	20.373
⅞	18.594	18.966	19.338	19.709	20.081	20.453	20.825	21.197	21.569	21.941
15/16	19.922	20.320	20.719	21.117	21.516	21.914	22.313	22.711	23.109	23.508
1	21.250	21.675	22.100	22.525	22.950	23.375	23.800	24.225	24.650	25.075
⅛	23.906	24.384	24.863	25.341	25.819	26.297	26.775	27.253	27.731	28.209
¼	26.563	27.094	27.625	28.156	28.688	29.219	29.750	30.281	30.813	31.344
⅜	29.219	29.803	30.388	30.972	31.556	32.141	32.725	33.309	33.894	34.478
½	31.875	32.513	33.150	33.788	34.425	35.063	35.700	36.338	36.975	37.613
⅝	34.531	35.222	35.913	36.603	37.294	37.984	38.675	39.366	40.056	40.747
¾	37.188	37.931	38.675	39.419	40.163	40.906	41.650	42.394	43.138	43.881
⅞	39.844	40.641	41.438	42.234	43.031	43.828	44.625	45.422	46.219	47.016
2	42.500	43.350	44.200	45.050	45.900	46.750	47.600	48.450	49.300	50.150
⅛	45.156	46.059	46.963	47.866	48.769	49.672	50.575	51.478	52.381	53.284
¼	47.813	48.769	49.725	50.681	51.638	52.594	53.550	54.506	55.463	56.419

$7\frac{1}{2}$—$8\frac{5}{8}$
$\frac{1}{32}$—$2\frac{1}{4}$

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches									
	7½	7⅝	7¾	7⅞	8	8⅛	8¼	8⅜	8½	8⅝
1/32	.797	.810	.823	.837	.850	.863	.877	.890	.903	.916
1/16	1.594	1.620	1.647	1.673	1.700	1.727	1.753	1.780	1.806	1.833
3/32	2.391	2.430	2.470	2.510	2.550	2.590	2.630	2.670	2.709	2.749
⅛	3.188	3.241	3.294	3.347	3.400	3.453	3.506	3.559	3.613	3.666
5/32	3.984	4.051	4.117	4.184	4.250	4.316	4.383	4.449	4.516	4.582
3/16	4.781	4.861	4.941	5.020	5.100	5.180	5.259	5.339	5.419	5.498
7/32	5.578	5.671	5.764	5.857	5.950	6.043	6.136	6.229	6.322	6.415
¼	6.375	6.481	6.588	6.694	6.800	6.906	7.013	7.119	7.225	7.331
5/16	7.969	8.102	8.234	8.367	8.500	8.633	8.766	8.898	9.031	9.164
⅜	9.563	9.722	9.881	10.041	10.200	10.359	10.519	10.678	10.838	10.997
7/16	11.156	11.342	11.528	11.714	11.900	12.086	12.272	12.458	12.644	12.830
½	12.750	12.963	13.175	13.388	13.600	13.813	14.025	14.238	14.450	14.663
9/16	14.344	14.583	14.822	15.061	15.300	15.539	15.778	16.017	16.256	16.495
⅝	15.938	16.203	16.469	16.734	17.000	17.266	17.531	17.797	18.063	18.328
11/16	17.531	17.823	18.116	18.408	18.700	18.992	19.284	19.577	19.869	20.161
¾	19.125	19.444	19.763	20.081	20.400	20.719	21.038	21.356	21.675	21.994
13/16	20.719	21.064	21.409	21.755	22.100	22.445	22.791	23.136	23.481	23.827
⅞	22.313	22.684	23.056	23.428	23.800	24.172	24.544	24.916	25.288	25.659
15/16	23.906	24.305	24.703	25.102	25.500	25.898	26.297	26.695	27.094	27.492
1	25.500	25.925	26.350	26.775	27.200	27.625	28.050	28.475	28.900	29.325
⅛	28.688	29.166	29.644	30.122	30.600	31.078	31.556	32.034	32.513	32.991
¼	31.875	32.406	32.938	33.469	34.000	34.531	35.063	35.594	36.125	36.656
⅜	35.063	35.647	36.231	36.816	37.400	37.984	38.569	39.153	39.738	40.322
½	38.250	38.888	39.525	40.163	40.800	41.438	42.075	42.713	43.350	43.988
⅝	41.438	42.128	42.819	43.509	44.200	44.891	45.581	46.272	46.963	47.653
¾	44.625	45.369	46.113	46.856	47.600	48.344	49.088	49.831	50.575	51.319
⅞	47.813	48.609	49.406	50.203	51.000	51.797	52.594	53.391	54.188	54.984
2	51.000	51.850	52.700	53.550	54.400	55.250	56.100	56.950	57.800	58.650
⅛	54.188	55.091	55.994	56.897	57.800	58.703	59.606	60.509	61.413	62.316
¼	57.375	58.331	59.288	60.244	61.200	62.156	63.113	64.069	65.025	65.981

$8\frac{3}{4}$—10
$\frac{1}{32}$—$2\frac{1}{4}$

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches									
	8¾	8⅞	9	9⅛	9¼	9⅜	9½	9⅝	9¾	10
1/32	.930	.943	.956	.970	.983	.996	1.009	1.023	1.036	1.063
1/16	1.859	1.886	1.913	1.939	1.966	1.992	2.019	2.045	2.072	2.125
3/32	2.789	2.829	2.869	2.909	2.948	2.988	3.028	3.068	3.108	3.188
1/8	3.719	3.772	3.825	3.878	3.931	3.984	4.038	4.091	4.144	4.250
5/32	4.648	4.715	4.781	4.848	4.914	4.980	5.047	5.113	5.180	5.313
3/16	5.578	5.658	5.738	5.817	5.897	5.977	6.056	6.136	6.216	6.375
7/32	6.508	6.601	6.694	6.787	6.880	6.973	7.066	7.159	7.252	7.438
1/4	7.438	7.544	7.650	7.756	7.863	7.969	8.075	8.181	8.288	8.500
5/16	9.297	9.430	9.563	9.695	9.828	9.961	10.094	10.227	10.359	10.625
3/8	11.156	11.316	11.475	11.634	11.794	11.953	12.113	12.272	12.431	12.750
7/16	13.016	13.202	13.388	13.573	13.759	13.945	14.131	14.317	14.503	14.875
1/2	14.875	15.088	15.300	15.513	15.725	15.938	16.150	16.363	16.575	17.000
9/16	16.734	16.973	17.213	17.452	17.691	17.930	18.169	18.408	18.647	19.125
5/8	18.594	18.859	19.125	19.391	19.656	19.922	20.188	20.453	20.719	21.250
11/16	20.453	20.745	21.038	21.330	21.622	21.914	22.206	22.498	22.791	23.375
3/4	22.313	22.631	22.950	23.269	23.588	23.906	24.225	24.544	24.863	25.500
13/16	24.172	24.517	24.863	25.208	25.553	25.898	26.244	26.589	26.934	27.625
7/8	26.031	26.403	26.775	27.147	27.519	27.891	28.263	28.634	29.006	29.750
15/16	27.891	28.289	28.688	29.086	29.484	29.883	30.281	30.680	31.078	31.875
1	29.750	30.175	30.600	31.025	31.450	31.875	32.300	32.725	33.150	34.000
1/8	33.469	33.947	34.425	34.903	35.381	35.859	36.338	36.816	37.294	38.250
1/4	37.188	37.719	38.250	38.781	39.313	39.844	40.375	40.906	41.438	42.500
3/8	40.906	41.491	42.075	42.659	43.244	43.828	44.413	44.997	45.581	46.750
1/2	44.625	45.263	45.900	46.538	47.175	47.813	48.450	49.088	49.725	51.000
5/8	48.344	49.034	49.725	50.416	51.106	51.797	52.488	53.178	53.869	55.250
3/4	52.063	52.806	53.550	54.294	55.038	55.781	56.525	57.269	58.013	59.500
7/8	55.781	56.578	57.375	58.172	58.969	59.766	60.563	61.359	62.156	63.750
2	59.500	60.350	61.200	62.050	62.900	63.750	64.600	65.450	66.300	68.000
1/8	63.219	64.122	65.025	65.928	66.831	67.734	68.638	69.541	70.444	72.250
1/4	66.938	67.894	68.850	69.806	70.763	71.719	72.675	73.631	74.588	76.500

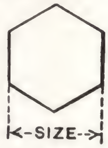
$10\frac{1}{4}$—12
$\frac{1}{32}$—$2\frac{1}{4}$

FLAT BAR STEEL

WEIGHT PER LINEAR FOOT, POUNDS

Thickness, Inches	Width, Inches							
	10¼	10½	10¾	11	11¼	11½	11¾	12
1/32	1.089	1.116	1.142	1.169	1.195	1.222	1.248	1.275
1/16	2.178	2.231	2.284	2.338	2.391	2.444	2.497	2.550
3/32	3.267	3.347	3.427	3.506	3.586	3.666	3.745	3.825
1/8	4.356	4.463	4.569	4.675	4.781	4.888	4.994	5.100
5/32	5.445	5.578	5.711	5.844	5.977	6.109	6.242	6.375
3/16	6.534	6.694	6.853	7.013	7.172	7.331	7.491	7.650
7/32	7.623	7.809	7.995	8.181	8.367	8.553	8.739	8.925
1/4	8.713	8.925	9.138	9.350	9.563	9.775	9.988	10.200
5/16	10.891	11.156	11.422	11.688	11.953	12.219	12.484	12.750
3/8	13.069	13.388	13.706	14.025	14.344	14.663	14.981	15.300
7/16	15.247	15.619	15.991	16.363	16.734	17.106	17.478	17.850
1/2	17.425	17.850	18.275	18.700	19.125	19.550	19.975	20.400
9/16	19.603	20.081	20.559	21.038	21.516	21.994	22.472	22.950
5/8	21.781	22.313	22.844	23.375	23.906	24.438	24.969	25.500
11/16	23.959	24.544	25.128	25.713	26.297	26.881	27.466	28.050
3/4	26.138	26.775	27.413	28.050	28.688	29.325	29.963	30.600
13/16	28.316	29.006	29.697	30.388	31.078	31.769	32.459	33.150
7/8	30.494	31.238	31.981	32.725	33.469	34.213	34.956	35.700
15/16	32.672	33.469	34.266	35.063	35.859	36.656	37.453	38.250
1	34.850	35.700	36.550	37.400	38.250	39.100	39.950	40.800
1/8	39.206	40.163	41.119	42.075	43.031	43.988	44.944	45.900
1/4	43.563	44.625	45.688	46.750	47.813	48.875	49.938	51.000
3/8	47.919	49.088	50.256	51.425	52.594	53.763	54.931	56.100
1/2	52.275	53.550	54.825	56.100	57.375	58.650	59.925	61.200
5/8	56.631	58.013	59.394	60.775	62.156	63.538	64.919	66.300
3/4	60.988	62.475	63.963	65.450	66.938	68.425	69.913	71.400
7/8	65.344	66.938	68.531	70.125	71.719	73.313	74.906	76.500
2	69.700	71.400	73.100	74.800	76.500	78.200	79.900	81.600
1/8	74.056	75.863	77.669	79.475	81.281	83.088	84.894	86.700
1/4	78.413	80.325	82.238	84.150	86.063	87.975	89.888	91.800

AREAS AND WEIGHTS OF HEXAGON BARS



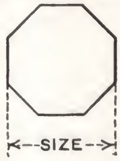
Size, Inches	Area, Sq. In.	Pounds per Foot
1/16	.0034	.0115
5/64	.0053	.0180
3/32	.0076	.0259
7/64	.0104	.0352
1/8	.0135	.0460
9/64	.0171	.0582
5/32	.0211	.0719
11/64	.0256	.0870
3/16	.0304	.1035
13/64	.0357	.1215
7/32	.0414	.1409
15/64	.0476	.1617
1/4	.0541	.1840
17/64	.0611	.2078
9/32	.0685	.2329
19/64	.0763	.2595
5/16	.0846	.2875
21/64	.0932	.3170
11/32	.1023	.3479
23/64	.1118	.3803
3/8	.1218	.4141
25/64	.1321	.4493
13/32	.1429	.4860
27/64	.1541	.5241
7/16	.1658	.5636
29/64	.1778	.6046
15/32	.1903	.6470
31/64	.2032	.6908
1/2	.2165	.7361
17/32	.2444	.8310
9/16	.2740	.9317
19/32	.3053	1.038
5/8	.3383	1.150
21/32	.3730	1.268
11/16	.4093	1.392
23/32	.4474	1.521
3/4	.4871	1.656
25/32	.5286	1.797
13/16	.5717	1.944
27/32	.6165	2.096
7/8	.6631	2.254
29/32	.7113	2.418

Size, Inches	Area, Sq. In.	Pounds per Foot
15/16	.761	2.588
31/32	.813	2.763
1	.866	2.945
1 1/32	.921	3.131
1 1/16	.978	3.324
1 3/32	1.036	3.523
1 1/8	1.096	3.727
1 5/32	1.158	3.937
1 3/16	1.221	4.152
1 7/32	1.286	4.374
1 1/4	1.353	4.601
1 9/32	1.422	4.834
1 5/16	1.492	5.072
1 11/32	1.564	5.317
1 3/8	1.637	5.567
1 13/32	1.713	5.823
1 7/16	1.790	6.085
1 15/32	1.868	6.352
1 1/2	1.949	6.625
1 17/32	2.031	6.904
1 9/16	2.114	7.189
1 19/32	2.200	7.479
1 5/8	2.287	7.775
1 21/32	2.376	8.077
1 11/16	2.466	8.385
1 23/32	2.558	8.698
1 3/4	2.652	9.018
1 25/32	2.748	9.342
1 13/16	2.845	9.673
1 27/32	2.944	10.01
1 7/8	3.045	10.35
1 29/32	3.147	10.70
1 15/16	3.251	11.05
1 31/32	3.357	11.41
2	3.464	11.78
2 1/32	3.573	12.15
2 1/16	3.684	12.53
2 3/32	3.796	12.91
2 1/8	3.911	13.30
2 5/32	4.027	13.69
2 3/16	4.144	14.09
2 7/32	4.263	14.50

Size, Inches	Area, Sq. In.	Pounds per Foot
2 1/4	4.384	14.91
2 9/32	4.507	15.32
2 5/16	4.631	15.75
2 11/32	4.757	16.17
2 3/8	4.885	16.61
2 13/32	5.014	17.05
2 7/16	5.145	17.49
2 15/32	5.278	17.95
2 1/2	5.413	18.40
2 17/32	5.549	18.87
2 9/16	5.687	19.33
2 19/32	5.826	19.81
2 5/8	5.967	20.29
2 21/32	6.110	20.78
2 11/16	6.255	21.27
2 23/32	6.401	21.76
2 3/4	6.549	22.27
2 25/32	6.699	22.78
2 13/16	6.850	23.29
2 27/32	7.003	23.81
2 7/8	7.158	24.34
2 29/32	7.315	24.87
2 15/16	7.473	25.41
2 31/32	7.633	25.95
3	7.794	26.50
3 1/32	7.957	27.06
3 1/16	8.122	27.62
3 3/32	8.289	28.18
3 1/8	8.457	28.75
3 5/32	8.627	29.33
3 3/16	8.799	29.92
3 7/32	8.972	30.51
3 1/4	9.147	31.10
3 9/32	9.324	31.70
3 5/16	9.503	32.31
3 11/32	9.683	32.92
3 3/8	9.865	33.54
3 13/32	10.05	34.16
3 7/16	10.23	34.79
3 15/32	10.42	35.43
3 1/2	10.61	36.07
3 17/32	10.80	36.72

Size, Inches	Area, Sq. In.	Pounds per Foot
3 9/16	10.99	37.37
3 19/32	11.18	38.03
3 5/8	11.38	38.69
3 21/32	11.58	39.36
3 11/16	11.78	40.04
3 23/32	11.98	40.72
3 3/4	12.18	41.41
3 25/32	12.38	42.10
3 13/16	12.59	42.80
3 27/32	12.80	43.50
3 7/8	13.00	44.21
3 29/32	13.21	44.93
3 15/16	13.43	45.65
3 31/32	13.64	46.38
4	13.86	47.11
4 1/8	14.74	50.10
4 1/4	15.64	53.18
4 3/8	16.58	56.36
4 1/2	17.54	59.63
4 5/8	18.52	62.98
4 3/4	19.54	66.43
4 7/8	20.58	69.98
5	21.65	73.61
5 1/4	23.87	81.16
5 1/2	26.20	89.07
5 3/4	28.63	97.35
6	31.18	106.0
6 1/4	33.83	115.0
6 1/2	36.59	124.4
6 3/4	39.46	134.2
7	42.44	144.3
7 1/4	45.52	154.8
7 1/2	48.71	165.6
7 3/4	52.02	176.9
8	55.43	188.4
8 1/4	58.94	200.4
8 1/2	62.57	212.7
8 3/4	66.31	225.4
9	70.15	238.5
9 1/4	74.10	251.9
9 1/2	78.16	265.7
9 3/4	82.33	279.9
10	86.60	294.4

AREAS AND WEIGHTS OF OCTAGON BARS



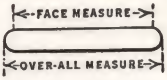
Size, Inches	Area, Sq. In.	Pounds per Foot
1/16	.0032	.0110
5/64	.0051	.0172
3/32	.0073	.0248
7/64	.0099	.0337
1/8	.0129	.0440
9/64	.0164	.0557
5/32	.0202	.0688
11/64	.0245	.0832
3/16	.0291	.0990
13/64	.0342	.1162
7/32	.0396	.1348
15/64	.0455	.1547
1/4	.0518	.1760
17/64	.0585	.1987
9/32	.0655	.2228
19/64	.0730	.2482
5/16	.0809	.2751
21/64	.0892	.3033
11/32	.0979	.3328
23/64	.1070	.3638
3/8	.1165	.3961
25/64	.1264	.4298
13/32	.1367	.4649
27/64	.1474	.5013
7/16	.1586	.5391
29/64	.1701	.5783
15/32	.1820	.6189
31/64	.1944	.6608
1/2	.2071	.7042
17/32	.2338	.7949
9/16	.2621	.8912
19/32	.2921	.9930
5/8	.3236	1.100
21/32	.3568	1.213
11/16	.3916	1.331
23/32	.4280	1.455
3/4	.4660	1.584
25/32	.5056	1.719
13/16	.5469	1.859
27/32	.5898	2.005
7/8	.6343	2.157
29/32	.6804	2.313

Size, Inches	Area, Sq. In.	Pounds per Foot
15/16	.728	2.476
31/32	.777	2.643
1	.828	2.817
1 1/32	.881	2.995
1 1/16	.935	3.180
1 3/32	.991	3.370
1 1/8	1.048	3.565
1 5/32	1.108	3.766
1 3/16	1.168	3.972
1 7/32	1.231	4.184
1 1/4	1.294	4.401
1 9/32	1.360	4.624
1 5/16	1.427	4.852
1 11/32	1.496	5.086
1 3/8	1.566	5.325
1 13/32	1.638	5.570
1 7/16	1.712	5.820
1 15/32	1.787	6.076
1 1/2	1.864	6.338
1 17/32	1.942	6.604
1 9/16	2.023	6.877
1 19/32	2.104	7.154
1 5/8	2.188	7.438
1 21/32	2.273	7.727
1 11/16	2.359	8.021
1 23/32	2.447	8.321
1 3/4	2.537	8.626
1 25/32	2.628	8.937
1 13/16	2.722	9.253
1 27/32	2.816	9.575
1 7/8	2.912	9.902
1 29/32	3.010	10.24
1 15/16	3.110	10.57
1 31/32	3.211	10.92
2	3.314	11.27
2 1/32	3.418	11.62
2 1/16	3.524	11.98
2 3/32	3.632	12.35
2 1/8	3.741	12.72
2 5/32	3.852	13.10
2 3/16	3.964	13.48
2 7/32	4.078	13.87

Size, Inches	Area, Sq. In.	Pounds per Foot
2 1/4	4.194	14.26
2 9/32	4.311	14.66
2 5/16	4.430	15.06
2 11/32	4.551	15.47
2 3/8	4.673	15.89
2 13/32	4.797	16.31
2 7/16	4.922	16.73
2 15/32	5.049	17.17
2 1/2	5.178	17.60
2 17/32	5.308	18.05
2 9/16	5.440	18.50
2 19/32	5.573	18.95
2 5/8	5.708	19.41
2 21/32	5.845	19.87
2 11/16	5.983	20.34
2 23/32	6.123	20.82
2 3/4	6.265	21.30
2 25/32	6.408	21.79
2 13/16	6.553	22.28
2 27/32	6.699	22.78
2 7/8	6.847	23.28
2 29/32	6.997	23.79
2 15/16	7.148	24.30
2 31/32	7.301	24.82
3	7.456	25.35
3 1/32	7.612	25.88
3 1/16	7.770	26.42
3 3/32	7.929	26.96
3 1/8	8.090	27.51
3 5/32	8.253	28.06
3 3/16	8.417	28.62
3 7/32	8.583	29.18
3 1/4	8.750	29.75
3 9/32	8.919	30.33
3 5/16	9.090	30.91
3 11/32	9.262	31.49
3 3/8	9.436	32.08
3 13/32	9.612	32.68
3 7/16	9.789	33.28
3 15/32	9.968	33.89
3 1/2	10.15	34.50
3 17/32	10.33	35.12

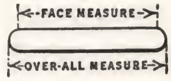
Size, Inches	Area, Sq. In.	Pounds per Foot
3 9/16	10.51	35.75
3 19/32	10.70	36.38
3 5/8	10.89	37.01
3 21/32	11.07	37.65
3 11/16	11.26	38.30
3 23/32	11.46	38.95
3 3/4	11.65	39.61
3 25/32	11.84	40.27
3 13/16	12.04	40.94
3 27/32	12.24	41.61
3 7/8	12.44	42.29
3 29/32	12.64	42.98
3 15/16	12.84	43.67
3 31/32	13.05	44.37
4	13.25	45.07
4 1/8	14.10	47.93
4 1/4	14.96	50.88
4 3/8	15.86	53.91
4 1/2	16.78	57.04
4 5/8	17.72	60.25
4 3/4	18.69	63.55
4 7/8	19.69	66.94
5	20.71	70.42
5 1/4	22.83	77.63
5 1/2	25.06	85.20
5 3/4	27.39	93.13
6	29.82	101.4
6 1/4	32.36	110.0
6 1/2	35.00	119.0
6 3/4	37.75	128.3
7	40.59	138.0
7 1/4	43.54	148.1
7 1/2	46.60	158.4
7 3/4	49.76	169.2
8	53.02	180.3
8 1/4	56.38	191.7
8 1/2	59.85	203.5
8 3/4	63.43	215.6
9	67.10	228.1
9 1/4	70.88	241.0
9 1/2	74.77	254.2
9 3/4	78.75	267.8
10	82.84	281.7

WEIGHTS OF ROUND EDGE FLATS



POUNDS PER LINEAR FOOT

FACE MEASURE

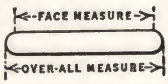


Face Measure, Inches	THICKNESS, B. W. G. AND INCHES									
	No. 13	No. 12	No. 11	No. 10	No. 9	No. 8	1/8	3/16	1/4	5/16
3/8	.132	.153	.170	.192	.215	.243	.178	.281	.393	.514
7/16	.152	.176	.196	.221	.246	.278	.204	.321	.446	.581
1/2	.172	.199	.221	.249	.278	.313	.231	.361	.499	.647
9/16	.192	.223	.247	.278	.309	.348	.258	.400	.552	.714
5/8	.213	.246	.272	.306	.341	.383	.284	.440	.605	.780
11/16	.233	.269	.298	.335	.372	.418	.311	.480	.659	.847
3/4	.253	.292	.323	.363	.403	.453	.337	.520	.712	.913
13/16	.273	.315	.349	.392	.435	.488	.364	.560	.765	.979
7/8	.293	.338	.374	.420	.466	.523	.390	.600	.818	1.046
15/16	.314	.362	.400	.448	.498	.558	.417	.639	.871	1.112
1	.334	.385	.425	.477	.529	.593	.444	.679	.924	1.179
1/16	.354	.408	.451	.505	.561	.628	.470	.719	.977	1.245
1/8	.374	.431	.476	.534	.592	.663	.497	.759	1.030	1.311
3/16	.394	.454	.502	.562	.624	.699	.523	.799	1.084	1.378
1/4	.414	.477	.527	.591	.655	.734	.550	.839	1.137	1.444
5/16	.435	.501	.553	.619	.686	.769	.576	.879	1.190	1.511
3/8	.455	.524	.578	.648	.718	.804	.603	.918	1.243	1.577
7/16	.475	.547	.604	.676	.749	.839	.629	.958	1.296	1.643
1/2	.495	.570	.629	.705	.781	.874	.656	.998	1.349	1.710
9/16	.515	.593	.655	.733	.812	.909	.683	1.038	1.402	1.776
5/8	.536	.616	.680	.762	.844	.944	.709	1.078	1.455	1.843
11/16	.556	.640	.706	.790	.875	.979	.736	1.118	1.509	1.909
3/4	.576	.663	.731	.819	.907	1.014	.762	1.157	1.562	1.975
13/16	.596	.686	.757	.847	.938	1.049	.789	1.197	1.615	2.042
7/8	.616	.709	.782	.876	.970	1.084	.815	1.237	1.668	2.108
15/16	.637	.732	.808	.904	1.001	1.119	.842	1.277	1.721	2.175
2	.657	.755	.833	.933	1.032	1.154	.869	1.317	1.774	2.241
1/16	.677	.778	.859	.961	1.064	1.189	.895	1.357	1.827	2.307
1/8	.697	.802	.884	.989	1.095	1.224	.922	1.396	1.880	2.374
3/16	.717	.825	.910	1.018	1.127	1.260	.948	1.436	1.934	2.440

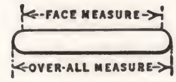
To obtain Over-all Measure for any thickness, add to Face Measure the Increment given in table below for corresponding thickness.

THICKNESS, B. W. G. AND INCHES									
No. 13	No. 12	No. 11	No. 10	No. 9	No. 8	1/8	3/16	1/4	5/16
INCREMENT, INCHES									
.0475	.0545	.0600	.0670	.0740	.0825	1/16	3/32	1/8	5/32

WEIGHTS OF ROUND EDGE FLATS



POUNDS PER LINEAR FOOT
FACE MEASURE
(Continued)

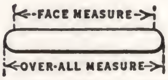


Face Measure, Inches	THICKNESS, INCHES 3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
3/8	.645	.785	.935	1.139	1.261	1.383	1.505	1.755	1.886	2.017	2.148
7/16	.725	.878	1.041	1.259	1.394	1.529	1.665	1.928	2.072	2.216	2.361
1/2	.805	.971	1.147	1.378	1.527	1.675	1.824	2.100	2.258	2.416	2.573
9/16	.884	1.064	1.253	1.498	1.659	1.821	1.984	2.273	2.444	2.615	2.786
5/8	.964	1.157	1.360	1.617	1.792	1.967	2.143	2.446	2.630	2.814	2.998
11/16	1.044	1.250	1.466	1.737	1.925	2.114	2.302	2.618	2.816	3.013	3.211
3/4	1.123	1.343	1.572	1.856	2.058	2.260	2.462	2.791	3.002	3.212	3.423
13/16	1.203	1.436	1.678	1.976	2.191	2.406	2.621	2.964	3.188	3.412	3.636
7/8	1.283	1.529	1.785	2.096	2.324	2.552	2.781	3.136	3.373	3.611	3.848
15/16	1.362	1.622	1.891	2.215	2.456	2.698	2.940	3.309	3.559	3.810	4.061
1	1.442	1.715	1.997	2.335	2.589	2.844	3.099	3.482	3.745	4.009	4.273
1/16	1.522	1.808	2.103	2.454	2.722	2.990	3.259	3.654	3.931	4.209	4.486
1/8	1.601	1.901	2.210	2.574	2.855	3.136	3.418	3.827	4.117	4.408	4.698
3/16	1.681	1.994	2.316	2.693	2.988	3.282	3.577	4.000	4.303	4.607	4.911
1/4	1.761	2.087	2.422	2.813	3.120	3.428	3.737	4.172	4.489	4.806	5.123
5/16	1.841	2.180	2.528	2.932	3.253	3.575	3.896	4.345	4.675	5.005	5.336
3/8	1.920	2.273	2.635	3.052	3.386	3.721	4.056	4.518	4.861	5.205	5.548
7/16	2.000	2.366	2.741	3.171	3.519	3.867	4.215	4.690	5.047	5.404	5.761
1/2	2.080	2.459	2.847	3.291	3.652	4.013	4.374	4.863	5.233	5.603	5.973
9/16	2.159	2.552	2.953	3.410	3.784	4.159	4.534	5.036	5.419	5.802	6.186
5/8	2.239	2.645	3.060	3.530	3.917	4.305	4.693	5.208	5.605	6.002	6.398
11/16	2.319	2.738	3.166	3.649	4.050	4.451	4.852	5.381	5.791	6.201	6.611
3/4	2.398	2.831	3.272	3.769	4.183	4.597	5.012	5.554	5.977	6.400	6.823
13/16	2.478	2.924	3.378	3.888	4.316	4.743	5.171	5.726	6.163	6.599	7.036
7/8	2.558	3.016	3.485	4.008	4.449	4.889	5.331	5.899	6.348	6.798	7.248
15/16	2.637	3.109	3.591	4.128	4.581	5.035	5.490	6.072	6.534	6.998	7.461
2	2.717	3.202	3.697	4.247	4.714	5.182	5.649	6.244	6.720	7.197	7.673
1/16	2.797	3.295	3.803	4.367	4.847	5.328	5.809	6.417	6.906	7.396	7.886
1/8	2.876	3.388	3.910	4.486	4.980	5.474	5.968	6.590	7.092	7.595	8.098
3/16	2.956	3.481	4.016	4.606	5.113	5.620	6.127	6.762	7.278	7.795	8.311

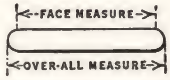
To obtain Over-all Measure for any thickness, add to Face Measure the Increment given in table below for corresponding thickness.

THICKNESS, INCHES 3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
INCREMENT, INCHES										
3/16	7/32	1/4	5/16	5/16	5/16	5/16	3/8	3/8	3/8	3/8

WEIGHTS OF ROUND EDGE FLATS



POUNDS PER LINEAR FOOT
FACE MEASURE
(Continued)

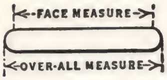


Face Measure, Inches	THICKNESS, B. W. G. AND INCHES									
	No. 13	No. 12	No. 11	No. 10	No. 9	No. 8	⅛	3/16	¼	5/16
2¼	.737	.848	.935	1.046	1.158	1.295	.975	1.476	1.987	2.507
5/16	.758	.871	.961	1.075	1.190	1.330	1.001	1.516	2.040	2.573
⅜	.778	.894	.986	1.103	1.221	1.365	1.028	1.556	2.093	2.639
7/16	.798	.917	1.012	1.132	1.253	1.400	1.054	1.596	2.146	2.706
½	.818	.941	1.037	1.160	1.284	1.435	1.081	1.636	2.199	2.772
⅝	.859	.987	1.088	1.217	1.347	1.505	1.134	1.715	2.305	2.905
¾	.899	1.033	1.139	1.274	1.410	1.575	1.187	1.795	2.412	3.038
⅞	.939	1.080	1.190	1.331	1.473	1.645	1.240	1.875	2.518	3.171
3	.980	1.126	1.241	1.388	1.536	1.715	1.294	1.954	2.624	3.304
⅛	1.020	1.172	1.292	1.445	1.599	1.785	1.347	2.034	2.730	3.436
¼	1.060	1.219	1.343	1.502	1.661	1.856	1.400	2.114	2.837	3.569
⅜	1.101	1.265	1.394	1.559	1.724	1.926	1.453	2.193	2.943	3.702
½	1.141	1.311	1.445	1.616	1.787	1.996	1.506	2.273	3.049	3.835
⅝	1.182	1.358	1.496	1.673	1.850	2.066	1.559	2.353	3.155	3.968
¾	1.222	1.404	1.547	1.730	1.913	2.136	1.612	2.432	3.262	4.100
⅞	1.262	1.450	1.598	1.787	1.976	2.206	1.665	2.512	3.368	4.233
4	1.303	1.497	1.649	1.844	2.039	2.276	1.719	2.592	3.474	4.366
⅛	1.343	1.543	1.700	1.901	2.102	2.346	1.772	2.671	3.580	4.499
¼	1.383	1.589	1.751	1.958	2.165	2.417	1.825	2.751	3.687	4.632
⅜	1.424	1.635	1.802	2.015	2.228	2.487	1.878	2.831	3.793	4.764
½	1.464	1.682	1.853	2.072	2.290	2.557	1.931	2.911	3.899	4 897
⅝	1.505	1.728	1.904	2.128	2.353	2.627	1.984	2.990	4.005	5.030
¾	1.545	1.774	1.955	2.185	2.416	2.697	2.037	3.070	4.112	5.163
⅞	1.585	1.821	2.006	2.242	2.479	2.767	2.090	3.150	4.218	5.296
5	1.626	1.867	2.057	2.299	2.542	2.837	2.144	3.229	4.324	5.429
⅛	1.666	1.913	2.108	2.356	2.605	2.907	2.197	3.309	4.430	5.561
¼	1.706	1.960	2.159	2.413	2.668	2.978	2.250	3.389	4.537	5.694
⅜	1.747	2.006	2.210	2.470	2.731	3.048	2.303	3.468	4.643	5.827
½	1.787	2.052	2.261	2.527	2.794	3.118	2.356	3.548	4.749	5.960
⅝	1.828	2.099	2.312	2.584	2.857	3.188	2.409	3.628	4.855	6.093
¾	1.868	2.145	2.363	2.641	2.919	3.258	2.462	3.707	4.962	6.225
⅞	1.908	2.191	2.414	2.698	2.982	3.328	2.515	3.787	5.068	6.358
6	1.949	2.238	2.465	2.755	3.045	3.398	2.569	3.867	5.174	6.491

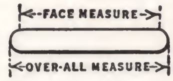
To obtain Over-all Measure for any thickness, add to Face Measure the Increment given in table below for corresponding thickness.

THICKNESS, B. W. G. AND INCHES									
No. 13	No. 12	No. 11	No. 10	No. 9	No. 8	⅛	3/16	¼	5/16
INCREMENT, INCHES									
.0475	.0545	.0600	.0670	.0740	.0825	1/16	3/32	⅛	5/32

WEIGHTS OF ROUND EDGE FLATS



POUNDS PER LINEAR FOOT
FACE MEASURE
(Continued)



Face Measure, Inches	THICKNESS, INCHES										
	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
2¼	3.036	3.574	4.122	4.725	5.245	5.766	6.287	6.935	7.464	7.994	8.523
5/16	3.116	3.667	4.228	4.845	5.378	5.912	6.446	7.108	7.650	8.193	8.736
3/8	3.195	3.760	4.335	4.964	5.511	6.058	6.606	7.280	7.836	8.392	8.948
7/16	3.275	3.853	4.441	5.084	5.644	6.204	6.765	7.453	8.022	8.591	9.161
1/2	3.355	3.946	4.547	5.203	5.777	6.350	6.924	7.625	8.208	8.791	9.373
5/8	3.514	4.132	4.760	5.442	6.042	6.643	7.243	7.971	8.580	9.189	9.798
3/4	3.673	4.318	4.972	5.681	6.308	6.935	7.562	8.316	8.952	9.587	10.223
7/8	3.833	4.504	5.185	5.921	6.574	7.227	7.881	8.661	9.323	9.986	10.648
3	3.992	4.690	5.397	6.160	6.839	7.519	8.199	9.007	9.695	10.384	11.073
1/8	4.151	4.876	5.610	6.399	7.105	7.811	8.518	9.352	10.067	10.783	11.498
1/4	4.311	5.062	5.822	6.638	7.370	8.103	8.837	9.697	10.439	11.181	11.923
3/8	4.470	5.248	6.035	6.877	7.636	8.396	9.156	10.043	10.811	11.579	12.348
1/2	4.630	5.434	6.247	7.116	7.902	8.688	9.474	10.388	11.183	11.978	12.773
5/8	4.789	5.620	6.460	7.355	8.167	8.980	9.793	10.733	11.555	12.377	13.198
3/4	4.948	5.806	6.672	7.594	8.433	9.272	10.112	11.079	11.927	12.775	13.623
7/8	5.108	5.991	6.885	7.833	8.699	9.564	10.431	11.424	12.298	13.173	14.048
4	5.267	6.177	7.097	8.072	8.964	9.857	10.749	11.769	12.670	13.572	14.473
1/8	5.426	6.363	7.310	8.311	9.230	10.149	11.068	12.115	13.042	13.970	14.898
1/4	5.586	6.549	7.522	8.550	9.495	10.441	11.387	12.460	13.414	14.369	15.323
3/8	5.745	6.735	7.735	8.789	9.761	10.733	11.706	12.805	13.786	14.767	15.748
1/2	5.905	6.921	7.947	9.028	10.027	11.025	12.024	13.150	14.158	15.166	16.173
5/8	6.064	7.107	8.160	9.267	10.292	11.318	12.343	13.496	14.530	15.564	16.598
3/4	6.223	7.293	8.372	9.506	10.558	11.610	12.662	13.841	14.902	15.962	17.023
7/8	6.383	7.479	8.585	9.746	10.824	11.902	12.981	14.186	15.273	16.361	17.448
5	6.542	7.665	8.797	9.985	11.089	12.194	13.299	14.532	15.645	16.759	17.873
1/8	6.701	7.851	9.010	10.224	11.355	12.486	13.618	14.877	16.017	17.158	18.298
1/4	6.861	8.037	9.222	10.463	11.620	12.778	13.937	15.222	16.389	17.556	18.723
3/8	7.020	8.223	9.435	10.702	11.886	13.071	14.256	15.568	16.761	17.955	19.148
1/2	7.180	8.409	9.647	10.941	12.152	13.363	14.574	15.913	17.133	18.353	19.573
5/8	7.339	8.595	9.860	11.180	12.417	13.655	14.893	16.258	17.505	18.752	19.998
3/4	7.498	8.781	10.072	11.419	12.683	13.947	15.212	16.604	17.877	19.150	20.423
7/8	7.658	8.966	10.285	11.658	12.949	14.239	15.531	16.949	18.248	19.548	20.848
6	7.817	9.152	10.497	11.897	13.214	14.532	15.849	17.294	18.620	19.947	21.273

To obtain Over-all Measure for any thickness, add to Face Measure the Increment given in table below for corresponding thickness.

THICKNESS, INCHES										
3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
INCREMENT, INCHES										
3/16	7/32	1/4	5/16	5/16	5/16	5/16	3/8	3/8	3/8	3/8

WEIGHTS OF ROUND EDGE FLATS

POUNDS PER LINEAR FOOT

FACE MEASURE

(Concluded)

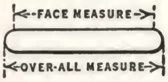
←FACE MEASURE→ ←OVER-ALL MEASURE→

Face Measure, In.	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4
	THICKNESS, INCHES											
2 1/4	9.217	9.755	10.293	10.832	11.570	12.118	12.664	13.212	13.996	14.552	15.108	15.664
5/16	9.442	9.994	10.546	11.097	11.849	12.410	12.970	13.531	14.328	14.897	15.467	16.036
3/8	9.668	10.233	10.798	11.363	12.128	12.702	13.276	13.850	14.660	15.242	15.825	16.408
7/16	9.894	10.472	11.050	11.629	12.407	12.994	13.581	14.168	14.992	15.588	16.184	16.780
1/2	10.120	10.711	11.303	11.894	12.686	13.286	13.887	14.487	15.324	15.933	16.542	17.152
5/8	10.571	11.189	11.807	12.426	13.244	13.871	14.498	15.125	15.988	16.624	17.260	17.895
3/4	11.023	11.667	12.312	12.957	13.802	14.455	15.108	15.762	16.652	17.314	17.977	18.639
7/8	11.474	12.146	12.817	13.488	14.359	15.039	15.719	16.400	17.316	18.005	18.694	19.383
3	11.926	12.624	13.321	14.019	14.917	15.624	16.330	17.037	17.980	18.696	19.411	20.127
1/8	12.378	13.102	13.826	14.551	15.475	16.208	16.941	17.675	18.644	19.386	20.128	20.870
1/4	12.829	13.580	14.331	15.082	16.033	16.793	17.552	18.312	19.308	20.077	20.846	21.614
3/8	13.281	14.058	14.835	15.613	16.591	17.377	18.163	18.950	19.972	20.767	21.563	22.358
1/2	13.732	14.536	15.340	16.144	17.149	17.961	18.774	19.587	20.637	21.458	22.280	23.102
5/8	14.184	15.014	15.845	16.676	17.706	18.546	19.385	20.225	21.301	22.149	22.997	23.845
3/4	14.635	15.492	16.349	17.207	18.264	19.130	19.996	20.862	21.965	22.839	23.714	24.589
7/8	15.087	15.971	16.854	17.738	18.822	19.714	20.607	21.500	22.629	23.530	24.432	25.333
4	15.538	16.449	17.359	18.269	19.380	20.299	21.218	22.137	23.293	24.221	25.149	26.077
1/8	15.990	16.927	17.864	18.801	19.938	20.883	21.829	22.775	23.957	24.911	25.866	26.820
1/4	16.442	17.405	18.368	19.332	20.495	21.468	22.440	23.412	24.621	25.602	26.583	27.564
3/8	16.893	17.883	18.873	19.863	21.053	22.052	23.051	24.050	25.285	26.292	27.300	28.308
1/2	17.345	18.361	19.378	20.394	21.611	22.636	23.662	24.687	25.949	26.983	28.127	29.052
5/8	17.796	18.839	19.882	20.926	22.169	23.221	24.273	25.325	26.613	27.674	28.735	29.795
3/4	18.248	19.317	20.387	21.457	22.727	23.805	24.883	25.962	27.277	28.364	29.452	30.539
7/8	18.699	19.796	20.892	21.988	23.284	24.389	25.494	26.600	27.941	29.055	30.169	31.283
5	19.151	20.274	21.396	22.519	23.842	24.974	26.105	27.237	28.605	29.746	30.886	32.027
1/8	19.603	20.752	21.901	23.051	24.400	25.558	26.716	27.875	29.269	30.436	31.603	32.770
1/4	20.054	21.230	22.406	23.582	24.958	26.143	27.327	28.512	29.933	31.127	32.321	33.514
3/8	20.506	21.708	22.910	24.113	25.516	26.727	27.938	29.150	30.597	31.817	33.038	34.258
1/2	20.957	22.186	23.415	24.644	26.074	27.311	28.549	29.787	31.262	32.508	33.755	35.002
5/8	21.409	22.664	23.920	25.176	26.631	27.896	29.160	30.425	31.926	33.199	34.472	35.745
3/4	21.860	23.142	24.424	25.707	27.189	28.480	29.771	31.062	32.590	33.889	35.189	36.489
7/8	22.312	23.621	24.929	26.238	27.747	29.064	30.382	31.700	33.254	34.580	35.907	37.233
6	22.763	24.099	25.434	26.769	28.305	29.649	30.993	32.337	33.918	35.271	36.624	37.977

To obtain Over-all Measure for any thickness, add to Face Measure the Increment given in table below for corresponding thickness.

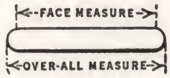
THICKNESS, INCHES	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4
INCREMENT, INCHES	7/16	7/16	7/16	7/16	1/2	1/2	1/2	1/2	9/16	9/16	9/16	9/16

WEIGHTS OF ROUND EDGE FLATS



POUNDS PER LINEAR FOOT

OVER-ALL MEASURE



Over-all Measure, Inches	THICKNESS, B. W. G. AND INCHES									
	No. 13	No. 12	No. 11	No. 10	No. 9	No. 8	1/8	3/16	1/4	5/16
3/8	.117	.133	.146	.162	.177	.196	.151	.221	.287	.348
7/16	.137	.156	.171	.190	.209	.232	.178	.261	.340	.415
1/2	.157	.179	.197	.219	.240	.267	.204	.301	.393	.481
9/16	.177	.202	.222	.247	.272	.302	.231	.341	.446	.548
5/8	.197	.226	.248	.276	.303	.337	.258	.380	.499	.614
11/16	.217	.249	.273	.304	.335	.372	.284	.420	.552	.680
3/4	.238	.272	.299	.333	.366	.407	.311	.460	.605	.747
13/16	.258	.295	.324	.361	.398	.442	.337	.500	.659	.813
7/8	.278	.318	.350	.389	.429	.477	.364	.540	.712	.880
15/16	.298	.341	.375	.418	.461	.512	.390	.580	.765	.946
1	.318	.365	.401	.446	.492	.547	.417	.620	.818	1.013
1/16	.339	.388	.426	.475	.523	.582	.444	.659	.871	1.079
1/8	.359	.411	.452	.503	.555	.617	.470	.699	.924	1.145
3/16	.379	.434	.477	.532	.586	.652	.497	.739	.977	1.212
1/4	.399	.457	.503	.560	.618	.687	.523	.779	1.030	1.278
5/16	.419	.480	.528	.589	.649	.722	.550	.819	1.084	1.345
3/8	.440	.503	.554	.617	.681	.757	.576	.859	1.137	1.411
7/16	.460	.527	.579	.646	.712	.793	.603	.898	1.190	1.477
1/2	.480	.550	.605	.674	.744	.828	.629	.938	1.243	1.544
9/16	.500	.573	.630	.703	.775	.863	.656	.978	1.296	1.610
5/8	.520	.596	.656	.731	.806	.898	.683	1.018	1.349	1.677
11/16	.540	.619	.681	.760	.838	.933	.709	1.058	1.402	1.743
3/4	.561	.642	.707	.788	.869	.968	.736	1.098	1.455	1.809
13/16	.581	.666	.732	.817	.901	1.003	.762	1.137	1.509	1.876
7/8	.601	.689	.758	.845	.932	1.038	.789	1.177	1.562	1.942
15/16	.621	.712	.783	.874	.964	1.073	.815	1.217	1.615	2.009
2	.641	.735	.809	.902	.995	1.108	.842	1.257	1.668	2.075
1/16	.662	.758	.834	.930	1.027	1.143	.869	1.297	1.721	2.141
1/8	.682	.781	.860	.959	1.058	1.178	.895	1.337	1.774	2.208
3/16	.702	.805	.885	.987	1.090	1.213	.922	1.377	1.827	2.274

To obtain Face Measure for any thickness, subtract from Over-all Measure the Increment given in table below for corresponding thickness.

THICKNESS, B. W. G. AND INCHES									
No. 13	No. 12	No. 11	No. 10	No. 9	No. 8	1/8	3/16	1/4	5/16
INCREMENT, INCHES									
.0475	.0545	.0600	.0670	.0740	.0825	1/16	3/32	1/8	5/32

WEIGHTS OF ROUND EDGE FLATS

POUNDS PER LINEAR FOOT

OVER-ALL MEASURE

(Continued)

FACE MEASURE / OVER-ALL MEASURE

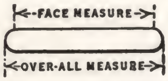
Over-all Measure, Inches	THICKNESS, INCHES										
	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
3/8	.406	.460	.510	.542	.597	.653	.709	.719	.770	.822	.873
7/16	.486	.553	.616	.661	.730	.799	.868	.892	.956	1.021	1.086
1/2	.566	.646	.722	.781	.863	.945	1.027	1.065	1.142	1.220	1.298
9/16	.645	.739	.828	.900	.995	1.091	1.187	1.237	1.328	1.419	1.511
5/8	.725	.832	.935	1.020	1.128	1.237	1.346	1.410	1.514	1.619	1.723
11/16	.805	.925	1.041	1.139	1.261	1.383	1.505	1.582	1.700	1.818	1.936
3/4	.884	1.018	1.147	1.259	1.394	1.529	1.665	1.755	1.886	2.017	2.148
13/16	.964	1.111	1.253	1.378	1.527	1.675	1.824	1.928	2.072	2.216	2.361
7/8	1.044	1.204	1.360	1.498	1.659	1.821	1.984	2.100	2.258	2.416	2.573
15/16	1.123	1.297	1.466	1.617	1.792	1.968	2.143	2.273	2.444	2.615	2.786
1	1.203	1.390	1.572	1.737	1.925	2.114	2.302	2.446	2.630	2.814	2.998
1/16	1.283	1.483	1.678	1.856	2.058	2.260	2.462	2.618	2.816	3.013	3.211
1/8	1.362	1.575	1.785	1.976	2.191	2.406	2.621	2.791	3.002	3.212	3.423
3/16	1.442	1.668	1.891	2.096	2.324	2.552	2.781	2.964	3.188	3.412	3.636
1/4	1.522	1.761	1.997	2.215	2.456	2.698	2.940	3.136	3.373	3.611	3.848
5/16	1.601	1.854	2.103	2.335	2.589	2.844	3.099	3.309	3.559	3.810	4.061
3/8	1.681	1.947	2.210	2.454	2.722	2.990	3.259	3.482	3.745	4.009	4.273
7/16	1.761	2.040	2.316	2.574	2.855	3.136	3.418	3.654	3.931	4.209	4.486
1/2	1.841	2.133	2.422	2.693	2.988	3.282	3.577	3.827	4.117	4.408	4.698
9/16	1.920	2.226	2.528	2.813	3.120	3.428	3.737	4.000	4.303	4.607	4.911
5/8	2.000	2.319	2.635	2.932	3.253	3.575	3.896	4.172	4.489	4.806	5.123
11/16	2.080	2.412	2.741	3.052	3.386	3.721	4.056	4.345	4.675	5.005	5.336
3/4	2.159	2.505	2.847	3.171	3.519	3.867	4.215	4.518	4.861	5.205	5.548
13/16	2.239	2.598	2.953	3.291	3.652	4.013	4.374	4.690	5.047	5.404	5.761
7/8	2.319	2.691	3.060	3.410	3.784	4.159	4.534	4.863	5.233	5.603	5.973
15/16	2.398	2.784	3.166	3.530	3.917	4.305	4.693	5.036	5.419	5.802	6.186
2	2.478	2.877	3.272	3.649	4.050	4.451	4.852	5.208	5.605	6.002	6.398
1/16	2.558	2.970	3.378	3.769	4.183	4.597	5.012	5.381	5.791	6.201	6.611
1/8	2.637	3.063	3.485	3.888	4.316	4.743	5.171	5.554	5.977	6.400	6.823
3/16	2.717	3.156	3.591	4.008	4.449	4.889	5.331	5.726	6.163	6.599	7.036

To obtain Face Measure for any thickness, subtract from Over-all Measure the Increment given in table below for corresponding thickness.

THICKNESS, INCHES										
3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
INCREMENT, INCHES										
3/16	7/32	1/4	5/16	5/16	5/16	5/16	3/8	3/8	3/8	3/8

No. 13—$\frac{5}{16}$
$2\frac{1}{4}$—6

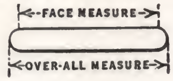
WEIGHTS OF ROUND EDGE FLATS



POUNDS PER LINEAR FOOT

OVER-ALL MEASURE

(Continued)



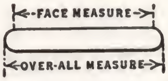
Over-all Measure, Inches	THICKNESS, B. W. G. AND INCHES									
	No. 13	No. 12	No. 11	No. 10	No. 9	No. 8	1/8	3/16	1/4	5/16
2 1/4	.722	.828	.911	1.016	1.121	1.248	.948	1.416	1.880	2.341
5/16	.742	.851	.936	1.044	1.152	1.283	.975	1.456	1.934	2.407
3/8	.763	.874	.962	1.073	1.184	1.318	1.001	1.496	1.987	2.473
7/16	.783	.897	.987	1.101	1.215	1.354	1.028	1.536	2.040	2.540
1/2	.803	.920	1.013	1.130	1.247	1.389	1.054	1.576	2.093	2.606
5/8	.843	.967	1.064	1.187	1.310	1.459	1.108	1.655	2.199	2.739
3/4	.884	1.013	1.115	1.244	1.373	1.529	1.161	1.735	2.305	2.872
7/8	.924	1.059	1.166	1.301	1.435	1.599	1.214	1.815	2.412	3.004
3	.964	1.106	1.217	1.358	1.498	1.669	1.267	1.895	2.518	3.138
1/8	1.005	1.152	1.268	1.415	1.561	1.739	1.320	1.974	2.624	3.270
1/4	1.045	1.198	1.319	1.472	1.624	1.809	1.373	2.054	2.730	3.403
3/8	1.086	1.245	1.370	1.528	1.687	1.879	1.426	2.134	2.837	3.536
1/2	1.126	1.291	1.421	1.585	1.750	1.950	1.479	2.213	2.943	3.669
5/8	1.166	1.337	1.472	1.642	1.813	2.020	1.533	2.293	3.049	3.802
3/4	1.207	1.384	1.523	1.699	1.876	2.090	1.586	2.373	3.155	3.934
7/8	1.247	1.430	1.574	1.756	1.939	2.160	1.639	2.452	3.262	4.067
4	1.287	1.476	1.625	1.813	2.002	2.230	1.692	2.532	3.368	4.200
1/8	1.328	1.523	1.676	1.870	2.064	2.300	1.745	2.612	3.474	4.333
1/4	1.368	1.569	1.727	1.927	2.127	2.370	1.798	2.691	3.580	4.466
3/8	1.409	1.615	1.778	1.984	2.190	2.440	1.851	2.771	3.687	4.598
1/2	1.449	1.662	1.829	2.041	2.253	2.511	1.905	2.851	3.793	4.731
5/8	1.489	1.708	1.880	2.098	2.316	2.581	1.958	2.930	3.899	4.864
3/4	1.530	1.754	1.931	2.155	2.379	2.651	2.011	3.010	4.005	4.997
7/8	1.570	1.801	1.982	2.212	2.442	2.721	2.064	3.090	4.112	5.130
5	1.610	1.847	2.033	2.269	2.505	2.791	2.117	3.170	4.218	5.263
1/8	1.651	1.893	2.084	2.326	2.568	2.861	2.170	3.249	4.324	5.395
1/4	1.691	1.940	2.135	2.383	2.631	2.931	2.223	3.329	4.430	5.528
3/8	1.732	1.986	2.186	2.440	2.693	3.001	2.276	3.409	4.537	5.661
1/2	1.772	2.032	2.237	2.497	2.756	3.072	2.330	3.488	4.643	5.794
5/8	1.812	2.079	2.288	2.554	2.819	3.142	2.383	3.568	4.749	5.927
3/4	1.853	2.125	2.339	2.611	2.882	3.212	2.436	3.648	4.855	6.059
7/8	1.893	2.171	2.390	2.667	2.945	3.282	2.489	3.727	4.962	6.192
6	1.933	2.218	2.441	2.724	3.008	3.352	2.542	3.807	5.068	6.325

To obtain Face Measure for any thickness, subtract from Over-all Measure the Increment given in table below for corresponding thickness.

THICKNESS, B. W. G. AND INCHES									
No. 13	No. 12	No. 11	No. 10	No. 9	No. 8	1/8	3/16	1/4	5/16
INCREMENT, INCHES									
.0475	.0545	.0600	.0670	.0740	.0825	1/16	3/32	1/8	5/32

$\frac{3}{8}$—1
$2\frac{1}{4}$—6

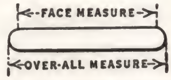
WEIGHTS OF ROUND EDGE FLATS



POUNDS PER LINEAR FOOT

OVER-ALL MEASURE

(Continued)



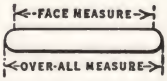
Over-all Measure, Inches	THICKNESS, INCHES										
	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
2¼	2.797	3.249	3.697	4.128	4.581	5.035	5.490	5.899	6.348	6.798	7.248
5/16	2.876	3.342	3.803	4.247	4.714	5.182	5.649	6.072	6.534	6.998	7.461
3/8	2.956	3.435	3.910	4.367	4.847	5.328	5.809	6.244	6.720	7.197	7.673
7/16	3.036	3.528	4.016	4.486	4.980	5.474	5.968	6.417	6.906	7.396	7.886
1/2	3.116	3.621	4.122	4.606	5.113	5.620	6.127	6.590	7.092	7.595	8.098
5/8	3.275	3.807	4.335	4.845	5.378	5.912	6.446	6.935	7.464	7.994	8.523
3/4	3.434	3.993	4.547	5.084	5.644	6.204	6.765	7.280	7.836	8.392	8.948
7/8	3.594	4.179	4.760	5.323	5.909	6.496	7.084	7.625	8.208	8.791	9.373
3	3.753	4.365	4.972	5.562	6.175	6.789	7.402	7.971	8.580	9.189	9.798
1/8	3.912	4.551	5.185	5.801	6.441	7.081	7.721	8.316	8.952	9.587	10.223
1/4	4.072	4.736	5.397	6.040	6.706	7.373	8.040	8.661	9.323	9.986	10.648
3/8	4.231	4.922	5.610	6.279	6.972	7.665	8.359	9.007	9.695	10.384	11.073
1/2	4.391	5.108	5.822	6.518	7.238	7.957	8.677	9.352	10.067	10.783	11.498
5/8	4.550	5.294	6.035	6.757	7.503	8.250	8.996	9.697	10.439	11.181	11.923
3/4	4.709	5.480	6.247	6.996	7.769	8.542	9.315	10.043	10.811	11.580	12.348
7/8	4.869	5.666	6.460	7.235	8.034	8.834	9.634	10.388	11.183	11.978	12.773
4	5.028	5.852	6.672	7.474	8.300	9.126	9.952	10.733	11.555	12.377	13.198
1/8	5.187	6.038	6.885	7.713	8.566	9.418	10.271	11.079	11.927	12.775	13.623
1/4	5.347	6.224	7.097	7.953	8.831	9.710	10.590	11.424	12.298	13.173	14.048
3/8	5.506	6.410	7.310	8.192	9.097	10.003	10.909	11.769	12.670	13.572	14.473
1/2	5.666	6.596	7.522	8.431	9.363	10.295	11.227	12.115	13.042	13.970	14.898
5/8	5.825	6.782	7.735	8.670	9.628	10.587	11.546	12.460	13.414	14.369	15.323
3/4	5.984	6.968	7.947	8.909	9.894	10.879	11.865	12.805	13.786	14.767	15.748
7/8	6.144	7.154	8.160	9.148	10.159	11.171	12.184	13.150	14.158	15.166	16.173
5	6.303	7.340	8.372	9.387	10.425	11.464	12.502	13.496	14.530	15.564	16.598
1/8	6.462	7.525	8.585	9.626	10.691	11.756	12.821	13.841	14.902	15.962	17.023
1/4	6.622	7.711	8.797	9.865	10.956	12.048	13.140	14.186	15.273	16.361	17.448
3/8	6.781	7.897	9.010	10.104	11.222	12.340	13.459	14.532	15.645	16.759	17.873
1/2	6.941	8.083	9.222	10.343	11.488	12.632	13.777	14.877	16.017	17.158	18.298
5/8	7.100	8.269	9.435	10.582	11.753	12.925	14.096	15.222	16.389	17.556	18.723
3/4	7.259	8.455	9.647	10.821	12.019	13.217	14.415	15.568	16.761	17.955	19.148
7/8	7.419	8.641	9.860	11.060	12.284	13.509	14.734	15.913	17.133	18.353	19.573
6	7.578	8.827	10.072	11.299	12.550	13.801	15.052	16.258	17.505	18.752	19.998

To obtain Face Measure for any thickness, subtract from Over-all Measure the Increment given in table below for corresponding thickness.

THICKNESS, INCHES										
3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
INCREMENT, INCHES										
3/16	7/32	1/4	5/16	5/16	5/16	5/16	3/8	3/8	3/8	3/8

$1\frac{1}{16}$—$1\frac{3}{4}$
$2\frac{1}{4}$—6

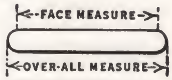
WEIGHTS OF ROUND EDGE FLATS



POUNDS PER LINEAR FOOT

OVER-ALL MEASURE

(Concluded)



Over-all Measure, Inches	THICKNESS, INCHES											
	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4
2 1/4	7.636	8.081	8.527	8.972	9.339	9.780	10.221	10.662	11.008	11.444	11.881	12.317
5/16	7.862	8.321	8.779	9.238	9.618	10.072	10.526	10.981	11.340	11.789	12.239	12.689
3/8	8.088	8.560	9.032	9.504	9.897	10.364	10.832	11.300	11.672	12.135	12.598	13.061
7/16	8.313	8.799	9.284	9.769	10.176	10.657	11.137	11.618	12.004	12.480	12.956	13.433
1/2	8.539	9.038	9.536	10.035	10.455	10.949	11.443	11.937	12.336	12.825	13.315	13.805
5/8	8.991	9.516	10.041	10.566	11.013	11.533	12.054	12.575	13.000	13.516	14.032	14.548
3/4	9.442	9.994	10.546	11.097	11.570	12.118	12.665	13.212	13.664	14.207	14.749	15.292
7/8	9.894	10.472	11.050	11.629	12.128	12.702	13.276	13.850	14.328	14.897	15.467	16.036
3	10.346	10.950	11.555	12.160	12.686	13.286	13.887	14.487	14.992	15.588	16.184	16.780
1/8	10.797	11.428	12.060	12.691	13.244	13.871	14.498	15.125	15.656	16.278	16.901	17.523
1/4	11.249	11.906	12.564	13.222	13.802	14.455	15.108	15.762	16.320	16.969	17.618	18.267
3/8	11.700	12.385	13.069	13.754	14.359	15.039	15.719	16.400	16.984	17.660	18.335	19.011
1/2	12.152	12.863	13.574	14.285	14.917	15.624	16.330	17.037	17.648	18.350	19.053	19.755
5/8	12.603	13.341	14.078	14.816	15.475	16.208	16.941	17.675	18.312	19.041	19.770	20.498
3/4	13.055	13.819	14.583	15.347	16.033	16.793	17.552	18.312	18.976	19.732	20.487	21.242
7/8	13.506	14.297	15.088	15.879	16.591	17.377	18.163	18.950	19.640	20.422	21.204	21.986
4	13.958	14.775	15.592	16.410	17.149	17.961	18.774	19.587	20.305	21.113	21.921	22.730
1/8	14.410	15.253	16.097	16.941	17.706	18.546	19.385	20.225	20.969	21.803	22.638	23.473
1/4	14.861	15.731	16.602	17.472	18.264	19.130	19.996	20.862	21.633	22.494	23.356	24.217
3/8	15.313	16.210	17.107	18.004	18.822	19.714	20.607	21.500	22.297	23.185	24.073	24.961
1/2	15.764	16.688	17.611	18.535	19.380	20.299	21.218	22.137	22.961	23.875	24.790	25.705
5/8	16.216	17.166	18.116	19.066	19.938	20.883	21.829	22.775	23.625	24.566	25.507	26.448
3/4	16.667	17.644	18.621	19.597	20.495	21.468	22.440	23.412	24.289	25.257	26.224	27.192
7/8	17.119	18.122	19.125	20.129	21.053	22.052	23.051	24.050	24.953	25.947	26.942	27.936
5	17.571	18.600	19.630	20.660	21.611	22.636	23.662	24.687	25.617	26.638	27.659	28.680
1/8	18.022	19.078	20.135	21.191	22.169	23.221	24.273	25.325	26.281	27.328	28.376	29.423
1/4	18.474	19.556	20.639	21.722	22.727	23.805	24.883	25.962	26.945	28.019	29.093	30.167
3/8	18.925	20.035	21.144	22.254	23.284	24.389	25.494	26.600	27.609	28.710	29.810	30.911
1/2	19.377	20.513	21.649	22.785	23.842	24.974	26.105	27.237	28.273	29.400	30.528	31.655
5/8	19.828	20.991	22.153	23.316	24.400	25.558	26.716	27.875	28.937	30.091	31.245	32.398
3/4	20.280	21.469	22.658	23.847	24.958	26.143	27.327	28.512	29.601	30.782	31.962	33.142
7/8	20.731	21.947	23.163	24.379	25.516	26.727	27.938	29.150	30.265	31.472	32.679	33.886
6	21.183	22.425	23.667	24.910	26.074	27.311	28.549	29.787	30.930	32.163	33.396	34.630

To obtain Face Measure for any thickness, subtract from Over-all Measure the Increment given in table below for corresponding thickness.

THICKNESS, INCHES											
1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4
INCREMENT, INCHES											
7/16	7/16	7/16	7/16	1/2	1/2	1/2	1/2	9/16	9/16	9/16	9/16

WEIGHTS OF FLAT ROLLED STRIP STEEL

POUNDS PER LINEAR FOOT

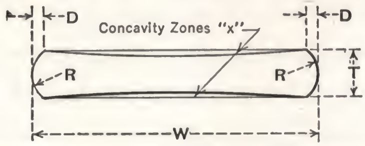
Thickness by Birmingham or Stubs Iron Wire Gage

For widths from ¼ inch to ¾ inch and thicknesses from No. 19 to No. 11 B.W.G.

Width, Inches	No. 19 .042 in.	No. 18 .049 in.	No. 17 .058 in.	No. 16 .065 in.	No. 15 .072 in.	No. 14 .083 in.	No. 13 .095 in.	No. 12 .109 in.	No. 11 .120 in.
1/4	.036	.042	.049	.055	.061	.071	.081	.093	.102
17/64	.038	.044	.052	.059	.065	.075	.086	.098	.108
9/32	.040	.047	.055	.062	.069	.079	.091	.104	.115
19/64	.042	.049	.059	.066	.073	.084	.096	.110	.121
5/16	.045	.052	.062	.069	.077	.088	.101	.116	.128
21/64	.047	.055	.065	.073	.080	.093	.106	.122	.134
11/32	.049	.057	.068	.076	.084	.097	.111	.127	.140
23/64	.051	.060	.071	.079	.088	.101	.116	.133	.147
3/8	.054	.062	.074	.083	.092	.106	.121	.139	.153
25/64	.056	.065	.077	.086	.096	.110	.126	.145	.159
13/32	.058	.068	.080	.090	.099	.115	.131	.151	.166
27/64	.060	.070	.083	.093	.103	.119	.136	.156	.172
7/16	.062	.073	.086	.097	.107	.123	.141	.162	.179
29/64	.065	.075	.089	.100	.111	.128	.146	.168	.185
15/32	.067	.078	.092	.104	.115	.132	.151	.174	.191
31/64	.069	.081	.096	.107	.119	.137	.156	.180	.198
1/2	.071	.083	.099	.111	.122	.141	.162	.185	.204
33/64	.074	.086	.102	.114	.126	.146	.167	.191	.210
17/32	.076	.089	.105	.117	.130	.150	.172	.197	.217
35/64	.078	.091	.108	.121	.134	.154	.177	.203	.223
9/16	.080	.094	.111	.124	.138	.159	.182	.208	.230
37/64	.083	.096	.114	.128	.142	.163	.187	.214	236
19/32	.085	.099	.117	.131	.145	.168	.192	.220	.242
39/64	.087	.102	.120	.135	.149	.172	.197	.226	.249
5/8	.089	.104	.123	.138	.153	.176	.202	.232	.255
41/64	.091	.107	.126	.142	.157	.181	.207	.237	.261
21/32	.094	.109	.129	.145	.161	.185	.212	.243	.268
43/64	.096	.112	.132	.148	.164	.190	.217	.249	.274
11/16	.098	.115	.136	.152	.168	.194	.222	.255	.281
45/64	.100	.117	.139	.155	.172	.198	.227	.261	.287
23/32	.103	.120	.142	.159	.176	.203	.232	.266	.293
47/64	.105	.122	.145	.162	.180	.207	.237	.272	.300
3/4	.107	.125	.148	.166	.184	.212	.242	.278	.306

TABLE OF WEIGHTS OF CONCAVE SPRING STEELS

BASED ON NOMINAL DIMENSIONS



Thickness		WIDTH, INCHES							
Gage No.	Inches	1¼	1½	1¾	2	2¼	2½	2¾	3
		WEIGHT IN POUNDS PER LINEAR FOOT							
7	.180	.74	.88	1.03	1.17	1.32	1.46	1.60	1.74
3/16"	.188	.77	.92	1.07	1.22	1.37	1.52	1.67	1.81
6	.203	.83	1.00	1.16	1.33	1.49	1.65	1.81	1.97
7/32"	.219	.89	1.07	1.25	1.43	1.61	1.78	1.95	2.13
5	.220	.90	1.08	1.26	1.44	1.62	1.79	1.96	2.14
4	.238	.97	1.17	1.36	1.56	1.75	1.94	2.13	2.32
1/4"	.250	1.02	1.23	1.43	1.63	1.84	2.04	2.24	2.44
3	.259	1.05	1.27	1.48	1.69	1.91	2.11	2.32	2.53
9/32"	.281	1.14	1.38	1.61	1.84	2.07	2.30	2.52	2.75
2	.284	1.15	1.39	1.63	1.86	2.09	2.32	2.55	2.77
1	.300	1.22	1.47	1.72	1.96	2.21	2.45	2.69	2.93
5/16"	.312	1.27	1.53	1.79	2.04	2.30	2.55	2.80	3.05
0	.340	1.37	1.66	1.94	2.22	2.50	2.77	3.05	3.33
11/32"	.344	1.40	1.68	1.96	2.25	2.53	2.81	3.09	3.37
3/8"	.375	1.51	1.82	2.14	2.44	2.76	3.06	3.37	3.67
00	.380	1.53	1.85	2.16	2.48	2.79	3.10	3.41	3.71
13/32"	.406	1.63	1.97	2.31	2.65	2.98	3.32	3.65	3.98
000	.425	1.70	2.06	2.41	2.76	3.12	3.47	3.81	4.16
7/16"	.438	1.75	2.12	2.48	2.84	3.21	3.57	3.92	4.28
0000	.454	1.81	2.19	2.57	2.95	3.33	3.70	4.07	4.44
15/32"	.469	1.86	2.26	2.65	3.04	3.43	3.82	4.20	4.59
1/2"	.500	1.98	2.40	2.82	3.24	3.66	4.07	4.48	4.89
9/16"	.563	2.20	2.68	3.15	3.62	4.09	4.55	5.02	5.48
5/8"	.625	2.44	2.97	3.50	4.02	4.54	5.06	5.58	6.09
11/16"	.688	2.69	3.26	3.84	4.42	5.00	5.57	6.14	6.71
3/4"	.750	2.93	3.56	4.19	4.82	5.45	6.07	6.70	7.32

CONCAVITY ZONES "X"

	WIDTH, INCHES							
	1¼	1½	1¾	2	2¼	2½	2¾	3
	DEPTH, INCHES							
Nominal	.006	.007	.008	.010	.011	.013	.015	.016
Maximum	.008	.009	.010	.012	.013	.015	.017	.018
Minimum	.003	.004	.005	.006	.007	.009	.011	.012
	WEIGHT IN POUNDS PER LINEAR FOOT							
Nominal	.013	.018	.024	.034	.042	.055	.069	.082

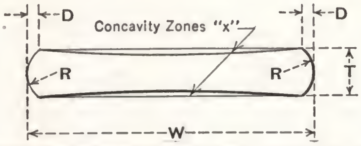
TO OBTAIN THE WEIGHT PER FOOT FOR THE ABOVE SPRING STEEL

Subtract from the Weight per Foot of corresponding Round Edge Flat, the Weight per Foot given in the Concavity Zones table; or subtract from the Weight per Foot of Square Edge Flat of same width and thickness, the sum of the Concavity Zones "X" weight and .51 times the thickness squared or $W \times T \times 3.4 - (\text{"X"} + .51\,T^2)$.

Concavity Depth = The difference in thickness between edge and center of spring.

TABLE OF WEIGHTS OF CONCAVE SPRING STEELS

BASED ON NOMINAL DIMENSIONS



Thickness		WIDTH, INCHES						
Gage No.	Inches	3¼	3½	3¾	4	4½	5	6
		WEIGHTS IN POUNDS PER LINEAR FOOT						
7	.180	1.88	2.02	2.15	2.29	2.52	2.79	3.35
3/16"	.188	1.96	2.11	2.25	2.39	2.63	2.92	3.50
6	.203	2.13	2.29	2.44	2.60	2.86	3.18	3.81
7/32"	.219	2.30	2.47	2.64	2.81	3.10	3.44	4.13
5	.220	2.31	2.49	2.65	2.82	3.12	3.46	4.15
4	.238	2.51	2.70	2.88	3.07	3.39	3.76	4.52
1/4"	.250	2.64	2.84	3.03	3.23	3.57	3.96	4.76
3	.259	2.73	2.94	3.14	3.35	3.71	4.11	4.94
9/32"	.281	2.97	3.20	3.41	3.64	4.04	4.48	5.38
2	.284	3.00	3.23	3.45	3.68	4.08	4.53	5.44
1	.300	3.18	3.42	3.65	3.89	4.32	4.80	5.76
5/16"	.312	3.31	3.56	3.81	4.06	4.51	5.01	6.02
0	.340	3.60	3.88	4.15	4.42	4.92	5.47	6.57
11/32"	.344	3.65	3.93	4.20	4.47	4.98	5.53	6.64
3/8"	.375	3.98	4.28	4.58	4.89	5.44	6.05	7.27
00	.380	4.03	4.34	4.64	4.95	5.52	6.13	7.37
13/32"	.406	4.30	4.64	4.97	5.30	5.91	6.57	7.89
000	.425	4.51	4.86	5.20	5.55	6.19	6.88	8.27
7/16"	.438	4.65	5.00	5.35	5.71	6.37	7.09	8.52
0000	.454	4.82	5.19	5.56	5.93	6.61	7.36	8.85
15/32"	.469	4.98	5.36	5.74	6.12	6.84	7.60	9.14
1/2"	.500	5.30	5.72	6.12	6.53	7.30	8.12	9.76
9/16"	.563	5.95	6.41	6.87	7.33	8.21	9.13	11.00
5/8"	.625	6.61	7.13	7.64	8.16	9.14	10.17	12.25
11/16"	.688	7.28	7.85	8.41	8.98	10.07	11.21	13.50
3/4"	.750	7.95	8.57	9.19	9.81	11.00	12.25	14.75

CONCAVITY ZONES "X"

	WIDTH, INCHES						
	3¼	3½	3¾	4	4½	5	6
	DEPTH, INCHES						
Nominal.........	.017	.018	.020	.021	.029	.030	.030
Maximum.......	.019	.020	.022	.023	.031	.036	.036
Minimum........	.013	.013	.015	.016	.023	.025	.025
	WEIGHT IN POUNDS PER LINEAR FOOT						
Nominal.........	.094	.107	.128	.143	.222	.255	.310

TO OBTAIN THE WEIGHT PER FOOT FOR THE ABOVE SPRING STEEL

Subtract from the Weight per Foot of corresponding Round Edge Flat, the Weight per Foot given in the Concavity Zones table; or subtract from the Weight per Foot of Square Edge Flat of same width and thickness, the sum of the Concavity Zones "X" weight and .51 times the thickness squared or $W \times T \times 3.4 - (\text{"X"} + .51\,T^2)$.

Concavity Depth = The difference in thickness between edge and center of spring.

WEIGHTS OF HALF-OVAL STEEL BARS

Size, Inches	Weight of one foot, Pounds	No. of feet in a bundle of 112 lbs.
3/8 x 3/32	.10	1120
3/8 x 1/8	.128	875
1/2 x 3/32	.125	896
1/2 x 1/8	.165	678
1/2 x 5/32	.180	622
1/2 x 3/16	.256	437
5/8 x 1/8	.210	533
5/8 x 5/32	.260	430
5/8 x 3/16	.336	333
5/8 x 1/4	.410	273
3/4 x 1/8	.272	411
3/4 x 5/32	.310	361
3/4 x 3/16	.384	292
3/4 x 1/4	.500	224
3/4 x 5/16	.620	180
7/8 x 1/8	.320	350
7/8 x 5/32	.380	295
7/8 x 3/16	.430	260
7/8 x 1/4	.580	193
7/8 x 5/16	.724	154
7/8 x 3/8	.900	124
1 x 1/8	.370	302
1 x 3/16	.500	224
1 x 1/4	.650	172
1 x 5/16	.830	135
1 x 3/8	1.00	112
1 1/8 x 1/4	.75	149
1 1/8 x 5/16	.92	122
1 1/8 x 3/8	1.10	102
1 1/4 x 1/4	.80	140
1 1/4 x 5/16	1.00	112
1 1/4 x 3/8	1.25	89
1 3/8 x 1/4	.88	127
1 3/8 x 5/16	1.12	100
1 3/8 x 3/8	1.45	77
1 1/2 x 1/4	1.00	112
1 1/2 x 5/16	1.28	87
1 1/2 x 3/8	1.50	74
1 1/2 x 7/16	1.75	64
1 1/2 x 1/2	2.00	56
1 3/4 x 3/8	1 75	64
1 3/4 x 7/16	2.05	54
1 3/4 x 1/2	2.30	48
2 x 3/8	1.80	62
2 x 7/16	2.30	49
2 x 1/2	2.60	43
2 1/2 x 3/8	2.40	
2 1/2 x 1/2	3.15	
2 1/2 x 5/8	4.10	
2 1/2 x 3/4	5.00	
3 x 3/8	3.00	
3 x 1/2	4.00	
3 x 5/8	5.00	
3 x 3/4	6.00	

$\frac{1}{16}$ TO $19\frac{7}{8}$

AREAS AND CIRCUMFERENCES OF CIRCLES

($\pi = 3.1416$)

Diameter	Area	Circumference	Diameter	Area	Circumference	Diameter	Area	Circumference	Diameter	Area	Circumference
1/16	.0031	.1963	5	19.6350	15.7080	10	78.540	31.4160	15	176.715	47.1240
⅛	.0123	.3927	⅛	20.6290	16.1007	⅛	80.516	31.8087	⅛	179.673	47.5167
¼	.0491	.7854	¼	21.6476	16.4934	¼	82.516	32.2014	¼	182.655	47.9094
⅜	.1104	1.1781	⅜	22.6907	16.8861	⅜	84.541	32.5941	⅜	185.661	48.3021
½	.1963	1.5708	½	23.7583	17.2788	½	86.590	32.9868	½	188.692	48.6948
⅝	.3068	1.9635	⅝	24.8505	17.6715	⅝	88.664	33.3795	⅝	191.748	49.0875
¾	.4418	2.3562	¾	25.9673	18.0642	¾	90.763	33.7722	¾	194.828	49.4802
⅞	.6013	2.7489	⅞	27.1086	18.4569	⅞	92.886	34.1649	⅞	197.933	49.8729
1	.7854	3.1416	6	28.2744	18.8496	11	95.033	34.5576	16	201.062	50.2656
⅛	.9940	3.5343	⅛	29.4648	19.2423	⅛	97.205	34.9503	⅛	204.216	50.6583
¼	1.2272	3.9270	¼	30.6797	19.6350	¼	99.402	35.3430	¼	207.395	51.0510
⅜	1.4849	4.3197	⅜	31.9191	20.0277	⅜	101.623	35.7357	⅜	210.598	51.4437
½	1.7671	4.7124	½	33.1831	20.4204	½	103.869	36.1284	½	213.825	51.8364
⅝	2.0739	5.1051	⅝	34.4717	20.8131	⅝	106.139	36.5211	⅝	217.077	52.2291
¾	2.4053	5.4978	¾	35.7848	21.2058	¾	108.434	36.9138	¾	220.354	52.6218
⅞	2.7612	5.8905	⅞	37.1224	21.5985	⅞	110.754	37.3065	⅞	223.655	53.0145
2	3.1416	6.2832	7	38.4846	21.9912	12	113.098	37.6992	17	226.981	53.4072
⅛	3.5466	6.6759	⅛	39.8713	22.3839	⅛	115.466	38.0919	⅛	230.331	53.7999
¼	3.9761	7.0686	¼	41.2826	22.7766	¼	117.859	38.4846	¼	233.706	54.1926
⅜	4.4301	7.4613	⅜	42.7184	23.1693	⅜	120.277	38.8773	⅜	237.105	54.5853
½	4.9087	7.8540	½	44.1787	23.5620	½	122.719	39.2700	½	240.529	54.9780
⅝	5.4119	8.2467	⅝	45.6636	23.9547	⅝	125.185	39.6627	⅝	243.977	55.3707
¾	5.9396	8.6394	¾	47.1731	24.3474	¾	127.677	40.0554	¾	247.450	55.7634
⅞	6.4918	9.0321	⅞	48.7071	24.7401	⅞	130.192	40.4481	⅞	250.948	56.1561
3	7.0686	9.4248	8	50.2656	25.1328	13	132.733	40.8408	18	254.470	56.5488
⅛	7.6699	9.8175	⅛	51.8487	25.5255	⅛	135.297	41.2335	⅛	258.016	56.9415
¼	8.2958	10.2102	¼	53.4563	25.9182	¼	137.887	41.6262	¼	261.587	57.3342
⅜	8.9462	10.6029	⅜	55.0884	26.3109	⅜	140.501	42.0189	⅜	265.183	57.7269
½	9.6211	10.9956	½	56.7451	26.7036	½	143.139	42.4116	½	268.803	58.1196
⅝	10.3206	11.3883	⅝	58.4264	27.0963	⅝	145.802	42.8043	⅝	272.448	58.5123
¾	11.0447	11.7810	¾	60.1322	27.4890	¾	148.490	43.1970	¾	276.117	58.9050
⅞	11.7933	12.1737	⅞	61.8625	27.8817	⅞	151.202	43.5897	⅞	279.811	59.2977
4	12.5664	12.5664	9	63.6174	28.2744	14	153.938	43.9824	19	283.529	59.6904
⅛	13.3641	12.9591	⅛	65.3968	28.6671	⅛	156.700	44.3751	⅛	287.272	60.0831
¼	14.1863	13.3518	¼	67.2008	29.0598	¼	159.485	44.7678	¼	291.040	60.4758
⅜	15.0330	13.7445	⅜	69.0293	29.4525	⅜	162.296	45.1605	⅜	294.832	60.8685
½	15.9043	14.1372	½	70.8823	29.8452	½	165.130	45.5532	½	298.648	61.2612
⅝	16.8002	14.5299	⅝	72.7599	30.2379	⅝	167.990	45.9459	⅝	302.489	61.6539
¾	17.7206	14.9226	¾	74.6621	30.6306	¾	170.874	46.3386	¾	306.355	62.0466
⅞	18.6655	15.3153	⅞	76.5889	31.0233	⅞	173.782	46.7313	⅞	310.245	62.4393

20 TO
39 7/8

AREAS AND CIRCUMFERENCES OF CIRCLES

($\pi = 3.1416$)

Diameter	Area	Circumference	Diameter	Area	Circumference	Diameter	Area	Circumference	Diameter	Area	Circumference
20	314.160	62.8320	25	490.875	78.5400	30	706.860	94.248	35	962.115	109.956
1/8	318.099	63.2247	1/8	495.796	78.9327	1/8	712.763	94.641	1/8	969.000	110.349
1/4	322.063	63.6174	1/4	500.742	79.3254	1/4	718.690	95.033	1/4	975.909	110.741
3/8	326.051	64.0101	3/8	505.712	79.7181	3/8	724.642	95.426	3/8	982.842	111.134
1/2	330.064	64.4028	1/2	510.706	80.1108	1/2	730.618	95.819	1/2	989.800	111.527
5/8	334.102	64.7955	5/8	515.726	80.5035	5/8	736.619	96.212	5/8	996.783	111.919
3/4	338.164	65.1828	3/4	520.769	80.8962	3/4	742.645	96.604	3/4	1003.790	112.312
7/8	342.250	65.5809	7/8	525.838	81.2889	7/8	748.695	96.997	7/8	1010.822	112.705
21	346.361	65.9736	26	530.930	81.6816	31	754.769	97.390	36	1017.878	113.098
1/8	350.497	66.3663	1/8	536.048	82.0743	1/8	760.869	97.782	1/8	1024.960	113.490
1/4	354.657	66.7590	1/4	541.190	82.4670	1/4	766.992	98.175	1/4	1032.065	113.883
3/8	358.842	67.1517	3/8	546.356	82.8597	3/8	773.140	98.568	3/8	1039.195	114.276
1/2	363.051	67.5444	1/2	551.547	83.2524	1/2	779.313	98.960	1/2	1046.349	114.668
5/8	367.285	67.9371	5/8	556.763	83.6451	5/8	785.510	99.353	5/8	1053.528	115.061
3/4	371.543	68.3298	3/4	562.003	84.0378	3/4	791.732	99.746	3/4	1060.732	115.454
7/8	375.826	68.7225	7/8	567.267	84.4305	7/8	797.979	100.138	7/8	1067.960	115.846
22	380.134	69.1152	27	572.557	84.8232	32	804.250	100.531	37	1075.213	116.239
1/8	384.466	69.5079	1/8	577.870	85.2159	1/8	810.545	100.924	1/8	1082.490	116.632
1/4	388.822	69.9006	1/4	583.209	85.6086	1/4	816.865	101.317	1/4	1089.792	117.025
3/8	393.203	70.2933	3/8	588.571	86.0013	3/8	823.210	101.709	3/8	1097.118	117.417
1/2	397.609	70.6860	1/2	593.959	86.3940	1/2	829.579	102.102	1/2	1104.469	117.810
5/8	402.038	71.0787	5/8	599.371	86.7867	5/8	835.972	102.495	5/8	1111.844	118.203
3/4	406.494	71.4714	3/4	604.807	87.1794	3/4	842.391	102.887	3/4	1119.244	118.595
7/8	410.973	71.8641	7/8	610.268	87.5721	7/8	848.833	103.280	7/8	1126.669	118.988
23	415.477	72.2568	28	615.754	87.9648	33	855.301	103.673	38	1134.118	119.381
1/8	420.004	72.6495	1/8	621.264	88.3575	1/8	861.792	104.065	1/8	1141.591	119.773
1/4	424.558	73.0422	1/4	626.798	88.7502	1/4	868.309	104.458	1/4	1149.089	120.166
3/8	429.135	73.4349	3/8	632.357	89.1429	3/8	874.850	104.851	3/8	1156.612	120.559
1/2	433.737	73.8276	1/2	637.941	89.5356	1/2	881.415	105.244	1/2	1164.159	120.952
5/8	438.364	74.2203	5/8	643.549	89.9283	5/8	888.005	105.636	5/8	1171.731	121.344
3/4	443.015	74.6130	3/4	649.182	90.3210	3/4	894.620	106.029	3/4	1179.327	121.737
7/8	447.690	75.0057	7/8	654.840	90.7137	7/8	901.259	106.422	7/8	1186.948	122.130
24	452.390	75.3984	29	660.521	91.1064	34	907.922	106.814	39	1194.593	122.522
1/8	457.115	75.7911	1/8	666.228	91.4991	1/8	914.611	107.207	1/8	1202.263	122.915
1/4	461.864	76.1838	1/4	671.959	91.8918	1/4	921.323	107.600	1/4	1209.958	123.308
3/8	466.638	76.5765	3/8	677.714	92.2845	3/8	928.061	107.992	3/8	1217.677	123.700
1/2	471.436	76.9692	1/2	683.494	92.6772	1/2	934.822	108.385	1/2	1225.420	124.093
5/8	476.259	77.3619	5/8	689.299	93.0699	5/8	941.609	108.778	5/8	1233.188	124.486
3/4	481.107	77.7546	3/4	695.128	93.4626	3/4	948.420	109.171	3/4	1240.981	124.879
7/8	485.979	78.1473	7/8	700.982	93.8553	7/8	955.255	109.563	7/8	1248.798	125.271

AREAS AND CIRCUMFERENCES OF CIRCLES

($\pi = 3.1416$)

Diameter	Area	Circumference	Diameter	Area	Circumference	Diameter	Area	Circumference	Diameter	Area	Circumference
40	1256.64	125.664	45	1590.43	141.372	50	1963.50	157.080	55	2375.83	172.788
⅛	1264.51	126.057	⅛	1599.28	141.765	⅛	1973.33	157.473	⅛	2386.65	173.181
¼	1272.40	126.449	¼	1608.16	142.157	¼	1983.18	157.865	¼	2397.48	173.573
⅜	1280.31	126.842	⅜	1617.05	142.550	⅜	1993.06	158.258	⅜	2408.34	173.966
½	1288.25	127.235	½	1625.97	142.943	½	2002.97	158.651	½	2419.23	174.359
⅝	1296.22	127.627	⅝	1634.92	143.335	⅝	2012.89	159.043	⅝	2430.14	174.751
¾	1304.21	128.020	¾	1643.89	143.728	¾	2022.85	159.436	¾	2441.07	175.144
⅞	1312.22	128.413	⅞	1652.89	144.121	⅞	2032.82	159.829	⅞	2452.03	175.537
41	1320.26	128.806	46	1661.91	144.514	51	2042.83	160.222	56	2463.01	175.930
⅛	1328.32	129.198	⅛	1670.95	144.906	⅛	2052.85	160.614	⅛	2474.02	176.322
¼	1336.41	129.591	¼	1680.02	145.299	¼	2062.90	161.007	¼	2485.05	176.715
⅜	1344.52	129.984	⅜	1689.11	145.692	⅜	2072.98	161.400	⅜	2496.11	177.108
½	1352.66	130.376	½	1698.23	146.084	½	2083.08	161.792	½	2507.19	177.500
⅝	1360.82	130.769	⅝	1707.37	146.477	⅝	2093.20	162.185	⅝	2518.30	177.893
¾	1369.00	131.162	¾	1716.54	146.870	¾	2103.35	162.578	¾	2529.43	178.286
⅞	1377.21	131.554	⅞	1725.73	147.262	⅞	2113.52	162.970	⅞	2540.58	178.678
42	1385.45	131.947	47	1734.95	147.655	52	2123.72	163.363	57	2551.76	179.071
⅛	1393.70	132.340	⅛	1744.19	148.048	⅛	2133.94	163.756	⅛	2562.97	179.464
¼	1401.99	132.733	¼	1753.45	148.441	¼	2144.19	164.149	¼	2574.20	179.857
⅜	1410.30	133.125	⅜	1762.74	148.833	⅜	2154.46	164.541	⅜	2585.45	180.249
½	1418.63	133.518	½	1772.06	149.226	½	2164.76	164.934	½	2596.73	180.642
⅝	1426.99	133.911	⅝	1781.40	149.619	⅝	2175.08	165.327	⅝	2608.03	181.035
¾	1435.37	134.303	¾	1790.76	150.011	¾	2185.42	165.719	¾	2619.36	181.427
⅞	1443.77	134.696	⅞	1800.15	150.404	⅞	2195.79	166.112	⅞	2630.71	181.820
43	1452.20	135.089	48	1809.56	150.797	53	2206.19	166.505	58	2642.09	182.213
⅛	1460.66	135.481	⅛	1819.00	151.189	⅛	2216.61	166.897	⅛	2653.49	182.605
¼	1469.14	135.874	¼	1828.46	151.582	¼	2227.05	167.290	¼	2664.91	182.998
⅜	1477.64	136.267	⅜	1837.95	151.975	⅜	2237.52	167.683	⅜	2676.36	183.391
½	1486.17	136.660	½	1847.46	152.368	½	2248.01	168.076	½	2687.84	183.784
⅝	1494.73	137.052	⅝	1856.99	152.760	⅝	2258.53	168.468	⅝	2699.33	184.176
¾	1503.30	137.445	¾	1866.55	153.153	¾	2269.07	168.861	¾	2710.86	184.569
⅞	1511.91	137.838	⅞	1876.14	153.546	⅞	2279.64	169.254	⅞	2722.41	184.962
44	1520.53	138.230	49	1885.75	153.938	54	2290.23	169.646	59	2733.98	185.354
⅛	1529.19	138.623	⅛	1895.38	154.331	⅛	2300.84	170.039	⅛	2745.57	185.747
¼	1537.86	139.016	¼	1905.04	154.724	¼	2311.48	170.432	¼	2757.20	186.140
⅜	1546.56	139.408	⅜	1914.72	155.116	⅜	2322.15	170.824	⅜	2768.84	186.532
½	1555.29	139.801	½	1924.43	155.509	½	2332.83	171.217	½	2780.51	186.925
⅝	1564.04	140.194	⅝	1934.16	155.902	⅝	2343.55	171.610	⅝	2792.21	187.318
¾	1572.81	140.587	¾	1943.91	156.295	¾	2354.29	172.003	¾	2803.93	187.711
⅞	1581.61	140.979	⅞	1953.69	156.687	⅞	2365.05	172.395	⅞	2815.67	188.103

60 TO
79⅞

AREAS AND CIRCUMFERENCES OF CIRCLES

($\pi = 3.1416$)

Diameter	Area	Circumference	Diameter	Area	Circumference	Diameter	Area	Circumference	Diameter	Area	Circumference
60	2827.44	188.496	65	3318.31	204.204	70	3848.46	219.912	75	4417.87	235.620
⅛	2839.23	188.889	⅛	3331.09	204.597	⅛	3862.22	220.305	⅛	4432.61	236.013
¼	2851.05	189.281	¼	3343.89	204.989	¼	3876.00	220.697	¼	4447.38	236.405
⅜	2862.89	189.674	⅜	3356.71	205.382	⅜	3889.80	221.090	⅜	4462.16	236.798
½	2874.76	190.067	½	3369.56	205.775	½	3903.63	221.483	½	4476.98	237.191
⅝	2886.65	190.459	⅝	3382.44	206.167	⅝	3917.49	221.875	⅝	4491.81	237.583
¾	2898.57	190.852	¾	3395.33	206.560	¾	3931.37	222.268	¾	4506.67	237.976
⅞	2910.51	191.245	⅞	3408.26	206.953	⅞	3945.27	222.661	⅞	4521.56	238.369
61	2922.47	191.638	66	3421.20	207.346	71	3959.20	223.054	76	4536.47	238.762
⅛	2934.46	192.030	⅛	3434.17	207.738	⅛	3973.15	223.446	⅛	4551.41	239.154
¼	2946.48	192.423	¼	3447.17	208.131	¼	3987.13	223.839	¼	4566.36	239.547
⅜	2958.52	192.816	⅜	3460.19	208.524	⅜	4001.13	224.232	⅜	4581.35	239.940
½	2970.58	193.208	½	3473.24	208.916	½	4015.16	224.624	½	4596.36	240.332
⅝	2982.67	193.601	⅝	3486.30	209.309	⅝	4029.21	225.017	⅝	4611.39	240.725
¾	2994.78	193.994	¾	3499.40	209.702	¾	4043.29	225.410	¾	4626.45	241.118
⅞	3006.92	194.386	⅞	3512.52	210.094	⅞	4057.39	225.802	⅞	4641.53	241.510
62	3019.08	194.779	67	3525.66	210.487	72	4071.51	226.195	77	4656.64	241.903
⅛	3031.26	195.172	⅛	3538.83	210.880	⅛	4085.66	226.588	⅛	4671.77	242.296
¼	3043.47	195.565	¼	3552.02	211.273	¼	4099.84	226.981	¼	4686.92	242.689
⅜	3055.71	195.957	⅜	3565.24	211.665	⅜	4114.04	227.373	⅜	4702.10	243.081
½	3067.97	196.350	½	3578.48	212.058	½	4128.26	227.766	½	4717.31	243.474
⅝	3080.25	196.743	⅝	3591.74	212.451	⅝	4142.51	228.159	⅝	4732.54	243.867
¾	3092.56	197.135	¾	3605.04	212.843	¾	4156.78	228.551	¾	4747.79	244.259
⅞	3104.89	197.528	⅞	3618.35	213.236	⅞	4171.08	228.944	⅞	4763.07	244.652
63	3117.25	197.921	68	3631.69	213.629	73	4185.40	229.337	78	4778.37	245.045
⅛	3129.64	198.313	⅛	3645.05	214.021	⅛	4199.74	229.729	⅛	4793.70	245.437
¼	3142.04	198.706	¼	3658.44	214.414	¼	4214.11	230.122	¼	4809.05	245.830
⅜	3154.47	199.099	⅜	3671.86	214.807	⅜	4228.51	230.515	⅜	4824.43	246.223
½	3166.93	199.492	½	3685.29	215.200	½	4242.93	230.908	½	4839.83	246.616
⅝	3179.41	199.884	⅝	3698.76	215.592	⅝	4257.37	231.300	⅝	4855.26	247.008
¾	3191.91	200.277	¾	3712.24	215.985	¾	4271.84	231.693	¾	4870.71	247.401
⅞	3204.44	200.670	⅞	3725.75	216.378	⅞	4286.33	232.086	⅞	4886.18	247.794
64	3217.00	201.062	69	3739.29	216.770	74	4300.85	232.478	79	4901.68	248.186
⅛	3229.58	201.455	⅛	3752.85	217.163	⅛	4315.39	232.871	⅛	4917.21	248.579
¼	3242.18	201.848	¼	3766.43	217.556	¼	4329.96	233.264	¼	4932.75	248.972
⅜	3254.81	202.240	⅜	3780.04	217.948	⅜	4344.55	233.656	⅜	4948.33	249.364
½	3267.46	202.633	½	3793.68	218.341	½	4359.17	234.049	½	4963.92	249.757
⅝	3280.14	203.026	⅝	3807.34	218.734	⅝	4373.81	234.442	⅝	4979.55	250.150
¾	3292.84	203.419	¾	3821.02	219.127	¾	4388.47	234.835	¾	4995.19	250.543
⅞	3305.56	203.811	⅞	3834.73	219.519	⅞	4403.16	235.227	⅞	5010.86	250.935

80 TO 100

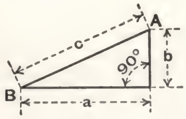
AREAS AND CIRCUMFERENCES OF CIRCLES

($\pi = 3.1416$)

Diameter	Area	Circumference	Diameter	Area	Circumference	Diameter	Area	Circumference	Diameter	Area	Circumference
80	5026.56	251.328	85	5674.51	267.036	90	6361.74	282.744	95	7088.24	298.452
⅛	5042.28	251.721	⅛	5691.22	267.429	⅛	6379.42	283.137	⅛	7106.90	298.845
¼	5058.03	252.113	¼	5707.94	267.821	¼	6397.13	283.529	¼	7125.59	299.237
⅜	5073.79	252.506	⅜	5724.69	268.214	⅜	6414.86	283.922	⅜	7144.31	299.630
½	5089.59	252.899	½	5741.47	268.607	½	6432.62	284.315	½	7163.04	300.023
⅝	5105.41	253.291	⅝	5758.27	268.999	⅝	6450.40	284.707	⅝	7181.81	300.415
¾	5121.25	253.684	¾	5775.10	269.392	¾	6468.21	285.100	¾	7200.60	300.808
⅞	5137.12	254.077	⅞	5791.94	269.785	⅞	6486.04	285.493	⅞	7219.41	301.201
81	5153.01	254.470	86	5808.82	270.178	91	6503.90	285.886	96	7238.25	301.594
⅛	5168.93	254.862	⅛	5825.72	270.570	⅛	6521.78	286.278	⅛	7257.11	301.986
¼	5184.87	255.255	¼	5842.64	270.963	¼	6539.68	286.671	¼	7275.99	302.379
⅜	5200.83	255.648	⅜	5859.59	271.356	⅜	6557.61	287.064	⅜	7294.91	302.772
½	5216.82	256.040	½	5876.56	271.748	½	6575.56	287.456	½	7313.84	303.164
⅝	5232.84	256.433	⅝	5893.55	272.141	⅝	6593.54	287.849	⅝	7332.80	303.557
¾	5248.88	256.826	¾	5910.58	272.534	¾	6611.55	288.242	¾	7351.79	303.950
⅞	5264.94	257.218	⅞	5927.62	272.926	⅞	6629.57	288.634	⅞	7370.79	304.342
82	5281.03	257.611	87	5944.69	273.319	92	6647.63	289.027	97	7389.83	304.735
⅛	5297.14	258.004	⅛	5961.79	273.712	⅛	6665.70	289.420	⅛	7408.89	305.128
¼	5313.28	258.397	¼	5978.91	274.105	¼	6683.80	289.813	¼	7427.97	305.521
⅜	5329.44	258.789	⅜	5996.05	274.497	⅜	6701.93	290.205	⅜	7447.08	305.913
½	5345.63	259.182	½	6013.22	274.890	½	6720.08	290.598	½	7466.21	306.306
⅝	5361.84	259.575	⅝	6030.41	275.283	⅝	6738.25	290.991	⅝	7485.37	306.699
¾	5378.08	259.967	¾	6047.63	275.675	¾	6756.45	291.383	¾	7504.55	307.091
⅞	5394.34	260.360	⅞	6064.87	276.068	⅞	6774.68	291.776	⅞	7523.75	307.484
83	5410.62	260.753	88	6082.14	276.461	93	6792.92	292.169	98	7542.98	307.877
⅛	5426.93	261.145	⅛	6099.43	276.853	⅛	6811.20	292.562	⅛	7562.24	308.270
¼	5443.26	261.538	¼	6116.74	277.246	¼	6829.49	292.954	¼	7581.52	308.662
⅜	5459.62	261.931	⅜	6134.08	277.638	⅜	6847.82	293.347	⅜	7600.82	309.055
½	5476.01	262.324	½	6151.45	278.032	½	6866.16	293.740	½	7620.15	309.448
⅝	5492.41	262.716	⅝	6168.84	278.424	⅝	6884.53	294.132	⅝	7639.50	309.840
¾	5508.84	263.109	¾	6186.25	278.817	¾	6902.93	294.525	¾	7658.88	310.233
⅞	5525.30	263.502	⅞	6203.69	279.210	⅞	6921.35	294.918	⅞	7678.28	310.626
84	5541.78	263.894	89	6221.15	279.602	94	6939.79	295.310	99	7697.71	311.018
⅛	5558.29	264.287	⅛	6238.64	279.995	⅛	6958.26	295.703	⅛	7717.16	311.411
¼	5574.82	264.680	¼	6256.15	280.388	¼	6976.76	296.096	¼	7736.63	311.804
⅜	5591.37	265.072	⅜	6273.69	280.780	⅜	6995.28	296.488	⅜	7756.13	312.196
½	5607.95	265.465	½	6291.25	281.173	½	7013.82	296.881	½	7775.66	312.589
⅝	5624.56	265.858	⅝	6308.84	281.566	⅝	7032.39	297.274	⅝	7795.21	312.982
¾	5641.18	266.251	¾	6326.45	281.959	¾	7050.98	297.667	¾	7814.78	313.375
⅞	5657.84	266.643	⅞	6344.08	282.351	⅞	7069.59	298.059	⅞	7834.38	313.767
									100	7854.00	314.160

MENSURATION OF PLANE FIGURES

RIGHT TRIANGLE



$A + B = 90°$

$\tan B = \cot A = \dfrac{b}{a}$

$c = \sqrt{a^2 + b^2}$

$a = \sqrt{c^2 - b^2}$

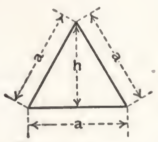
$b = \sqrt{c^2 - a^2}$

$\text{Area} = \dfrac{1}{2}\, a\, b$

$\phantom{\text{Area}} = \dfrac{1}{2}\, a^2 \tan B$

$\text{Perimeter} = a + b + c$

EQUILATERAL TRIANGLE



All Angles = 60°

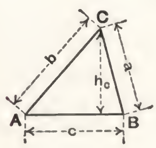
$h = \dfrac{\sqrt{3}}{2}\, a = .8660254\, a$

$\text{Area} = \dfrac{1}{2}\, a\, h = \dfrac{\sqrt{3}}{4}\, a^2$

$= .4330127\, a^2$

$\text{Perimeter} = 3a = 3.464102\, h$

OBLIQUE TRIANGLE



$A + B + C = 180° \qquad A = 180 - (B + C)*$ I

$\dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C} \qquad \therefore\ a = b\,\dfrac{\sin A}{\sin B}* \qquad s = \dfrac{1}{2}(a + b + c)$ II

$\dfrac{a+b}{a-b} = \dfrac{\tan\frac{1}{2}(A+B)}{\tan\frac{1}{2}(A-B)};\ \left(\dfrac{b+c}{b-c}\right) = \dfrac{\tan\frac{1}{2}(B+C)}{\tan\frac{1}{2}(B-C)};\ \left(\dfrac{c+a}{c-a}\right) = \dfrac{\tan\frac{1}{2}(C+A)}{\tan\frac{1}{2}(C-A)}$ III

$*a^2 = b^2 + c^2 - 2\,b\,c\cos A$ ① $\qquad *a = b\cos C + c\cos B \qquad *\cos A = \dfrac{b^2 + c^2 - a^2}{2\,b\,c}$

$b^2 = c^2 + a^2 - 2\,c\,a\cos B$ ② $\qquad b = c\cos A + a\cos C \qquad \cos B = \dfrac{c^2 + a^2 - b^2}{2\,c\,a}$ IV

$c^2 = a^2 + b^2 - 2\,a\,b\cos C$ ③ $\qquad c = a\cos B + b\cos A \qquad \cos C = \dfrac{a^2 + b^2 - c^2}{2\,a\,b}$

$\sin\dfrac{A}{2} = \sqrt{\dfrac{(s-b)(s-c)}{b\,c}}* \qquad \cos\dfrac{A}{2} = \sqrt{\dfrac{s(s-a)}{b\,c}}* \qquad \tan\dfrac{A}{2} = \sqrt{\dfrac{(s-b)(s-c)}{s(s-a)}}* = \dfrac{r}{s-a}*$ V

$h_c = a\sin B* = b\sin A* = \dfrac{2}{c}\sqrt{s(s-a)(s-b)(s-c)}\ *$ VI

$r = \sqrt{\dfrac{(s-a)(s-b)(s-c)}{s}} = (s-a)\tan\dfrac{A}{2}*,$ r = Radius of Inscribed Circle VII

$R = \dfrac{a}{2\sin A}* = \dfrac{a\,b\,c}{4\,(\text{Area})}$ R = Radius of Circumscribed Circle VIII

$\text{Area} = \dfrac{1}{2}\,c\,h_c* = \dfrac{1}{2}\,a\,c\sin B* = \dfrac{a^2\sin B\sin C*}{2\sin A} = \sqrt{s(s-a)(s-b)(s-c)} = r\,s$ IX

SOLUTION OF TRIANGLES

For Area, see IX

Given	Sought		
a, b, c	A, B, C	See II and V	
a, A, B	C	$180° - (A + B)$	
	b, c	See II	
a, b, A	B	See II	
	C	$180° - (A + B)$	
	c	See II or IV	
a, b, C	A	$\tan A = \dfrac{a\sin C}{b - a\cos C}$ or	$\dfrac{1}{2}(A + B) = 90° - \dfrac{C}{2}$
			$\tan\dfrac{1}{2}(A - B) = \dfrac{a-b}{a+b}\cot\dfrac{C}{2}$
	B	$180° - (A + C)$	
	c	See IV	

* It should be noted that ② is derived from ① by changing a to b, b to c, c to a, and A to B. Hereafter where 3 equations of the same form are obtained by rotating letters in this fashion, a * will be used. The three sets of equations in IV illustrate the procedure. Reference to the drawing will show the method.

MENSURATION OF PLANE FIGURES

SQUARE

Side = a $d = a\sqrt{2} = 1.4142136\,a$

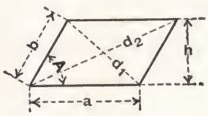
Diagonal = d Area = a^2

RECTANGLE

Base = b $d = \sqrt{a^2 + b^2}$

Side = a Area = a b

Diagonal = d



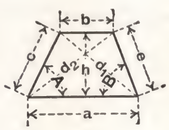
PARALLELOGRAM

Opposite Sides Parallel

$d_1 = \sqrt{a^2 + b^2 - 2\,ab\cos A}$ Area = ah = ab sin A

$d_2 = \sqrt{a^2 + b^2 + 2\,ab\cos A}$

$\sin A = \dfrac{h}{b}$



TRAPEZOID

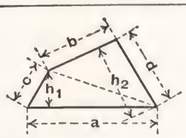
Two opposite sides Parallel Isosceles Trapezoid (A = B)

Area $= \frac{1}{2}h(a + b)$ Area $= \frac{1}{2}h(a+b) = \frac{1}{2}c\sin A(a + b)$

$a = c\cos A + b + e\cos B$ $= c\sin A\,(a - c\cos A)$

$\sin A = \dfrac{h}{c}$ $\sin B = \dfrac{h}{e}$ $= c\sin A\,(b + c\cos A)$

Solve as 2 triangles

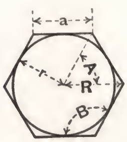


TRAPEZIUM

No sides parallel

Area $= \frac{1}{2}[ah_1 + bh_2]$

Solve as two triangles



REGULAR POLYGON

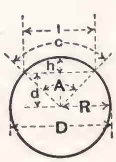
All sides equal; all angles equal.
n = Number of sides.

$A = \dfrac{360}{n}$ $B = \dfrac{n-2}{n}\,180°$

n =	3	4	6	8	n
a	3.4641016 r	2 r	1.1547005 r	.8284272 r	2 r tan A/2
r	.2886752 a	.5 a	.8660254 a	1.2071068 a	½a cot A/2
R	.5773503 a	.7071068 a	a	1.306563 a	½a csc A/2
Area	.4330127 a^2	a^2	2.598076 a^2	4.828427 a^2	¼ na^2 cotA/2

CIRCLE

A = Angle, degrees A_r = Angle, radians



C (Circumference) $= \pi D = 2\pi R$

$c = RA_r = \frac{1}{2}DA_r = D\cos^{-1}\dfrac{d}{R} = D\tan^{-1}\dfrac{l}{2d}$

$l = 2\sqrt{R^2 - d^2} = 2R\sin\dfrac{A}{2}$

$= 2d\tan\dfrac{A}{2} = 2\,d\tan\dfrac{c}{D}$

$d = \frac{1}{2}\sqrt{4R^2 - l^2} = \frac{1}{2}\sqrt{D^2 - l^2} = R\cos\dfrac{A}{2}$

$= \frac{1}{2}l\cot\dfrac{A}{2} = \frac{1}{2}l\cot\dfrac{c}{D}$ $h = R - d$

$A_r = \dfrac{c}{R} = \dfrac{2c}{D} = 2\cos^{-1}\dfrac{d}{R} = 2\tan^{-1}\dfrac{l}{2d} = 2\sin^{-1}\dfrac{l}{D}$

Area (Circle) $= \pi R^2 = \dfrac{\pi}{4}D^2 = \frac{1}{2}RC = \frac{1}{4}DC$

" (Sector) $= \frac{1}{2}Rc = \frac{1}{2}R^2A_r = \frac{1}{8}D^2A_r$

" (segment) = Area (sector)—Area (Triangle)

$= \frac{1}{2}R^2(A_r - \sin A) = \frac{1}{2}R\left(c - R\sin\dfrac{c}{R}\right)$

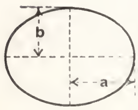
$= R^2\sin^{-1}\dfrac{l}{2R} - \dfrac{l}{4}\sqrt{4R^2 - l^2}$

$= R^2\cos^{-1}\dfrac{d}{R} - d\sqrt{R^2 - d^2}$

$= R^2\cos^{-1}\dfrac{R-h}{R} - (R-h)\sqrt{2Rh - h^2}$

MENSURATION OF PLANE FIGURES

ELLIPSE



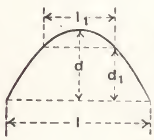
$U = \left(\frac{a-b}{a+b}\right)^2$ Ellipticity $= e = \frac{\sqrt{a^2-b^2}}{a}$ Area $= \pi ab$

$$\text{Perimeter} = s = \pi(a+b)\left[1 + \frac{1}{4}U + \frac{1}{64}U^2 + \frac{1}{256}U^3 + \frac{1}{512}U^4 + \frac{1}{1024}U^5 + \;.\;.\;.\;.\;\right]$$

$$= 4a\left[\int_0^{\frac{\pi}{2}} (1 - \sin^2\theta \sin^2\phi)^{1/2} d\phi\right] \quad \text{where} \quad \theta = \sin^{-1} e$$

Values of [. . .] (elliptic integrals) for various values of θ are found in Smithsonian Physical Tables and save calculating series.

PARABOLA



Length of arc (s)

Area $= \frac{2}{3} ld$

$$= \tfrac{1}{2}\sqrt{16d^2 + l^2} + .28782314 \frac{l^2}{d} \log_{10}\left(\frac{4d + \sqrt{16d^2 + l^2}}{l}\right)$$

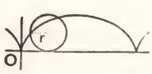
Height of segment $d_1 = \frac{d}{l^2}(l^2 - l_1^2)$.

$$= l\left[1 + \frac{2}{3}V - \frac{2}{5}V^2 + \;.\;.\;.\;.\;.\;.\right]$$

Width of " $l_1 = l\sqrt{\frac{d-d_1}{d}}$

$$V = \left(\frac{2d}{l}\right)^2$$

CYCLOID

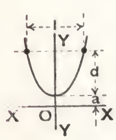


r = Radius of Generating Circle

Area $= 3\pi r^2$

Arc Length (s) $= 8r$

CATENARY



From table of hyperbolic functions find a solution of equation,

$$\cosh x = \frac{2xd}{l} + 1$$

$x = \frac{l}{2a}$ or $a = \frac{l}{2x}$

Length of Curve $= 2a \sinh x = \frac{l}{x} \sinh x$

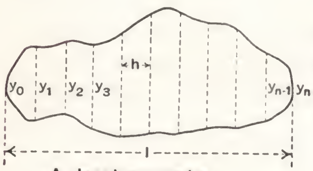
Plot curve $y = a \cosh x$ where $x < \frac{l}{2a}$

AREA BY APPROXIMATION

Divide l into n equal parts, by parallel lines.

Then $h = \frac{l}{n}$. n preferably 10 or greater.

Measure $y_0, y_1, y_2 \;.\;.\;.\;.\; y_{n-1}$ and y_n.



A_t least accurate,
A_s most "

Area, by Trapezoidal Rule (Boundary replaced by line segments)

$A_t = h\,[\tfrac{1}{2}(y_0 + y_n) + y_1 + y_2 + \;.\;.\;.\;.\;.\; y_{n-1}]$ n even or odd

Area, by Durand's Rule

$A_d = h\,[0.4(y_0 + y_n) + 1.1(y_1 + y_{n-1}) + y_2 + y_3 + \;.\;.\;.\; y_{n-2}]$
n even or odd

Area, by Simpson's Rule (Boundary replaced by 2d degree curves)

$A_s = \frac{h}{3}\,[(y_0 + y_n) + 4(y_1 + y_3 + \;.\;.\;.\;.\; y_{n-1}) + 2(y_2 + y_4 + \;.\;.\;.\; y_{n-2})]$
n even.

TRIGONOMETRIC FORMULAS

$\sin A = \dfrac{1}{\operatorname{cosec} A} = \sqrt{1-\cos^2 A} = \tan A \cos A = 2 \sin \tfrac{1}{2} A \cos \tfrac{1}{2} A$

$= \operatorname{vers} A \cot \tfrac{1}{2} A = \sqrt{\tfrac{1}{2} \operatorname{vers} 2A} = \sqrt{\tfrac{1}{2}(1-\cos 2A)}$

$\cos A = \dfrac{1}{\sec A} = \sqrt{1-\sin^2 A} = \cot A \sin A = 1-\operatorname{vers} A = 2\cos^2 \tfrac{1}{2} A - 1$

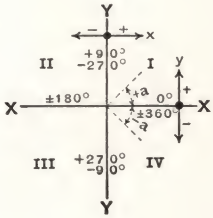
$= 1-2\sin^2 \tfrac{1}{2} A = \cos^2 \tfrac{1}{2} A - \sin^2 \tfrac{1}{2} A = \sqrt{\tfrac{1}{2}+\tfrac{1}{2}\cos 2A}$

$\tan A = \dfrac{1}{\cot A} = \dfrac{\sin A}{\cos A} = \sqrt{\sec^2 A - 1} = \sqrt{\dfrac{1}{\cos^2 A} - 1} = \dfrac{\sqrt{1-\cos^2 A}}{\cos A}$

$= \dfrac{\sin 2A}{1+\cos 2A} = \dfrac{1-\cos 2A}{\sin 2A} = \dfrac{\operatorname{vers} 2A}{\sin 2A} = \operatorname{exsec} A \cot \tfrac{1}{2} A$

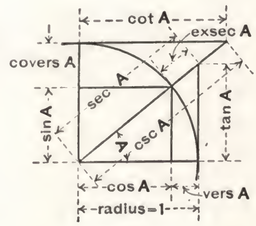
$\cot A = \dfrac{1}{\tan A} = \dfrac{\cos A}{\sin A} = \sqrt{\operatorname{cosec}^2 A - 1} = \dfrac{\sin 2A}{1-\cos 2A} = \dfrac{\sin 2A}{\operatorname{vers} 2A}$

$= \dfrac{1+\cos 2A}{\sin 2A} = \dfrac{\tan \frac{1}{2} A}{\operatorname{exsec} A}$



$\operatorname{vers} A = 1-\cos A = \sin A \tan \tfrac{1}{2} A = 2\sin^2 \tfrac{1}{2} A = \operatorname{exsec} A \cos A$

$\operatorname{exsec} A = \sec A - 1 = \tan A \tan \tfrac{1}{2} A = \dfrac{\operatorname{vers} A}{\cos A}$



$\sin \tfrac{1}{2} A = \sqrt{\dfrac{1-\cos A}{2}} = \sqrt{\dfrac{\operatorname{vers} A}{2}}$ $\qquad \cos \tfrac{1}{2} A = \sqrt{\dfrac{1+\cos A}{2}}$

$\tan \tfrac{1}{2} A = \dfrac{\tan A}{1+\sec A} = \operatorname{cosec} A - \cot A = \dfrac{1-\cos A}{\sin A} = \sqrt{\dfrac{1-\cos A}{1+\cos A}}$

$\cot \tfrac{1}{2} A = \dfrac{\sin A}{\operatorname{vers} A} = \dfrac{1+\cos A}{\sin A} = \dfrac{1}{\operatorname{cosec} A - \cot A}$

$\operatorname{vers} \tfrac{1}{2} A = \dfrac{\frac{1}{2} \operatorname{vers} A}{1+\sqrt{1-\frac{1}{2}\operatorname{vers} A}} = \dfrac{1-\cos A}{2+\sqrt{2(1+\cos A)}}$

$\operatorname{exsec} \tfrac{1}{2} A = \dfrac{1-\cos A}{(1+\cos A)+\sqrt{2(1+\cos A)}}$ $\qquad \sin 2A = 2\sin A \cos A$

$\cos 2A = 2\cos^2 A - 1 = \cos^2 A - \sin^2 A = 1-2\sin^2 A$

$\tan 2A = \dfrac{2\tan A}{1-\tan^2 A}$ $\qquad \cot 2A = \dfrac{\cot^2 A - 1}{2\cot A}$

$\operatorname{vers} 2A = 2\sin^2 A = 2\sin A \cos A \tan A$

$\operatorname{exsec} 2A = \dfrac{2\tan^2 A}{1-\tan^2 A}$

$\sin 3A = 3\sin A - 4\sin^3 A$

$\cos 3A = 4\cos^3 A - 3\cos A$

$\tan 3A = \dfrac{3\tan A - \tan^3 A}{1-3\tan^2 A}$

$\sin 4A = 4\sin A\cos A - 8\sin^3 A \cos A$

$\cos 4A = 1-8\cos^2 A + 8\cos^4 A$

$\tan 4A = \dfrac{4\tan A - 4\tan^3 A}{1-6\tan^2 A + \tan^4 A}$

$\sin(A+B) = \sin A \cos B + \sin B \cos A$

$\sin(A-B) = \sin A \cos B - \sin B \cos A$

$\cos(A+B) = \cos A \cos B - \sin A \sin B$

$\cos(A-B) = \cos A \cos B + \sin A \sin B$

$\sin A + \sin B = 2\sin \tfrac{1}{2}(A+B) \cos \tfrac{1}{2}(A-B)$

$\sin A - \sin B = 2\cos \tfrac{1}{2}(A+B) \sin \tfrac{1}{2}(A-B)$

$\cos A + \cos B = 2\cos \tfrac{1}{2}(A+B) \cos \tfrac{1}{2}(A-B)$

$\cos B - \cos A = 2\sin \tfrac{1}{2}(A+B) \sin \tfrac{1}{2}(A-B)$

$\sin^2 A - \sin^2 B = \cos^2 B - \cos^2 A$
$= \sin(A+B)\sin(A-B)$

$\cos^2 A - \sin^2 B = \cos(A+B)\cos(A-B)$

$\tan A + \tan B = \dfrac{\sin(A+B)}{\cos A \cos B}$

$\tan A - \tan B = \dfrac{\sin(A-B)}{\cos A \cos B}$

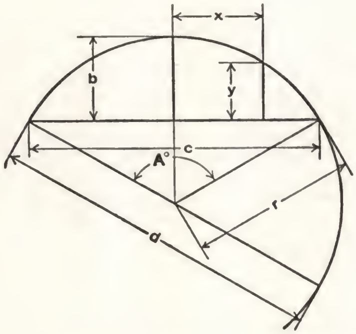
Range of Function Values

Quadrant		I	II	III	IV
Angles	+	0°- 90°	90°-180°	180°-270°	270°-360°
	−	270°-360°	180°-270°	90°-180°	0°- 90°
sin	+A	0 to +1	+1 to 0	0 to −1	−1 to 0
	−A	+1 to 0	0 to +1	−1 to 0	0 to −1
cos	+A	+1 to 0	0 to −1	−1 to 0	0 to +1
	−A	0 to +1	−1 to 0	0 to −1	+1 to 0
tan	+A	0 to +∞	−∞ to 0	0 to +∞	−∞ to 0
	−A	+∞ to 0	0 to −∞	+∞ to 0	0 to −∞
cot	+A	+∞ to 0	0 to −∞	+∞ to 0	0 to −∞
	−A	0 to +∞	−∞ to 0	0 to +∞	−∞ to 0

Functions of Angles Greater than 90°

Angle A	sin A	cos A	tan A	cot A
$0° \pm a$	$\pm \sin a$	$+ \cos a$	$\pm \tan a$	$\pm \cot a$
$90° \pm a$	$+ \cos a$	$\mp \sin a$	$\mp \cot a$	$\mp \tan a$
$180° \pm a$	$\mp \sin a$	$- \cos a$	$\pm \tan a$	$\pm \cot a$
$270° \pm a$	$- \cos a$	$\pm \sin a$	$\mp \cot a$	$\mp \tan a$
$360° \pm a$	$\pm \sin a$	$+ \cos a$	$\pm \tan a$	$\pm \cot a$

PROPERTIES OF THE CIRCLE



Circumference $= 6.28318\ r = 3.14159\ d$
Diameter $= 0.31831$ circumference
Area $= 3.14159\ r^2$

Arc $\quad a = \dfrac{\pi r\ A^\circ}{180^\circ} = 0.017453\ r\ A^\circ$

Angle $\quad A^\circ = \dfrac{180^\circ\ a}{\pi r} = 57.29578\ \dfrac{a}{r}$

Radius $r = \dfrac{4\ b^2 + c^2}{8\ b}$

Chord $\quad c = 2\sqrt{2\ br - b^2} = 2\ r \sin\dfrac{A}{2}$

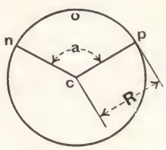
Rise $\quad b = r - \tfrac{1}{2}\sqrt{4\ r^2 - c^2} = \dfrac{c}{2}\tan\dfrac{A}{4}$

$\quad = 2\ r \sin^2\dfrac{A}{4} = r + y - \sqrt{r^2 - x^2}$

$y = b - r + \sqrt{r^2 - x^2}$

$x = \sqrt{r^2 - (r + y - b)^2}$

Diameter of circle of equal periphery as square = 1.27324 side of square
Side of square of equal periphery as circle = 0.78540 diameter of circle
Diameter of circle circumscribed about square = 1.41421 side of square
Side of square inscribed in circle = 0.70711 diameter of circle

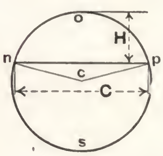


CIRCULAR SECTOR

R = radius of circle $\quad$ a = angle ncp in degrees

Area of Sector ncpo $= \tfrac{1}{2}$ (length of arc nop $\times$ R) $=$ Area of Circle $\times \dfrac{a}{360}$

$= 0.0087266 \times R^2 \times a$



CIRCULAR SEGMENT

R = radius of circle $\quad$ C = chord $\quad$ H = rise

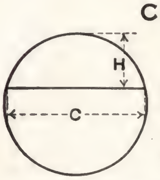
Area of Segment nop = Area of Sector ncpo—Area of triangle ncp

$= \dfrac{(\text{Length of arc nop} \times R) - C\,(R - H)}{2}$

Area of Segment nsp = Area of Circle − Area of Segment nop

CIRCULAR SEGMENT, From Table I, page 355

Given: Rise, H, and Chord, C



Area = Coefficient $\times$ H $\times$ C

Coefficient found opposite $\dfrac{H}{C}$

Interpolate for intermediate values of $\dfrac{H}{C}$

Example:

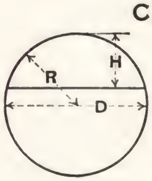
RISE = 1.49 $\quad$ CHORD = 3.52

$\dfrac{H}{C} = \dfrac{1.49}{3.52} = 0.4233 \qquad$ Coeff. = 0.7542

Area = H $\times$ C $\times$ Coeff. = 1.49 $\times$ 3.52 $\times$ 0.7542 = 3.9556

CIRCULAR SEGMENT, From Table II, pages 356, 357

Given: RISE, H, and DIAMETER, D = 2R



Area = Coefficient $\times$ D^2

Coefficient opposite $\dfrac{H}{D}$

Interpolate for intermediate values of $\dfrac{H}{D}$

Example:

RISE = $2\tfrac{7}{16}$ and DIAMETER = $5\tfrac{3}{32}$

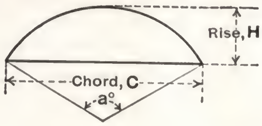
$\dfrac{H}{D} = 2.4375 \div 5.09375 = 0.478528$

Coefficient = 0.371233

Area = Coef. $\times$ d^2 = 0.371233 $\times$ 25.94629 = 9.6321

AREAS OF CIRCULAR SEGMENTS

TABLE I—FOR RATIOS OF RISE AND CHORD

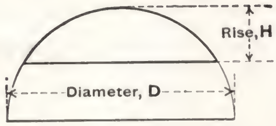


Area = C x H x coefficient

a	Coefficient	H/C	a	Coefficient	H/C	a	Coefficient	H/C	a	Coefficient	H/C
1	.6667	.0022	46	.6722	.1017	91	.6895	.2097	136	.7239	.3373
2	.6667	.0044	47	.6724	.1040	92	.6901	.2122	137	.7249	.3404
3	.6667	.0066	48	.6727	.1063	93	.6906	.2148	138	.7260	.3436
4	.6667	.0087	49	.6729	.1086	94	.6912	.2174	139	.7270	.3469
5	.6667	.0109	50	.6732	.1109	95	.6918	.2200	140	.7281	.3501
6	.6667	.0131	51	.6734	.1131	96	.6924	.2226	141	.7292	.3534
7	.6668	.0153	52	.6737	.1154	97	.6930	.2252	142	.7303	.3567
8	.6668	.0175	53	.6740	.1177	98	.6936	.2279	143	.7314	.3600
9	.6669	.0197	54	.6743	.1200	99	.6942	.2305	144	.7325	.3633
10	.6670	.0218	55	.6746	.1224	100	.6948	.2332	145	.7336	.3666
11	.6670	.0240	56	.6749	.1247	101	.6954	.2358	146	.7348	.3700
12	.6671	.0262	57	.6752	.1270	102	.6961	.2385	147	.7360	.3734
13	.6672	.0284	58	.6755	.1293	103	.6967	.2412	148	.7372	.3768
14	.6672	.0306	59	.6758	.1316	104	.6974	.2439	149	.7384	.3802
15	.6673	.0328	60	.6761	.1340	105	.6980	.2466	150	.7396	.3837
16	.6674	.0350	61	.6764	.1363	106	.6987	.2493	151	.7408	.3871
17	.6674	.0372	62	.6768	.1387	107	.6994	.2520	152	.7421	.3906
18	.6675	.0394	63	.6771	.1410	108	.7001	.2548	153	.7434	.3942
19	.6676	.0416	64	.6775	.1434	109	.7008	.2575	154	.7447	.3977
20	.6677	.0437	65	.6779	.1457	110	.7015	.2603	155	.7460	.4013
21	.6678	.0459	66	.6782	.1481	111	.7022	.2631	156	.7473	.4049
22	.6679	.0481	67	.6786	.1505	112	.7030	.2659	157	.7486	.4085
23	.6680	.0504	68	.6790	.1529	113	.7037	.2687	158	.7500	.4122
24	.6681	.0526	69	.6794	.1553	114	.7045	.2715	159	.7514	.4159
25	.6682	.0548	70	.6797	.1577	115	.7052	.2743	160	.7528	.4196
26	.6684	.0570	71	.6801	.1601	116	.7060	.2772	161	.7542	.4233
27	.6685	.0592	72	.6805	.1625	117	.7068	.2800	162	.7557	.4270
28	.6687	.0614	73	.6809	.1649	118	.7076	.2829	163	.7571	.4308
29	.6688	.0636	74	.6814	.1673	119	.7084	.2858	164	.7586	.4346
30	.6690	.0658	75	.6818	.1697	120	.7092	.2887	165	.7601	.4385
31	.6691	.0681	76	.6822	.1722	121	.7100	.2916	166	.7616	.4424
32	.6693	.0703	77	.6826	.1746	122	.7109	.2945	167	.7632	.4463
33	.6694	.0725	78	.6831	.1771	123	.7117	.2975	168	.7648	.4502
34	.6696	.0747	79	.6835	.1795	124	.7126	.3004	169	.7664	.4542
35	.6698	.0770	80	.6840	.1820	125	.7134	.3034	170	.7680	.4582
36	.6700	.0792	81	.6844	.1845	126	.7143	.3064	171	.7696	.4622
37	.6702	.0814	82	.6849	.1869	127	.7152	.3094	172	.7712	.4663
38	.6704	.0837	83	.6854	.1894	128	.7161	.3124	173	.7729	.4704
39	.6706	.0859	84	.6859	.1919	129	.7170	.3155	174	.7746	.4745
40	.6708	.0882	85	.6864	.1944	130	.7180	.3185	175	.7763	.4787
41	.6710	.0904	86	.6869	.1970	131	.7189	.3216	176	.7781	.4828
42	.6712	.0927	87	.6874	.1995	132	.7199	.3247	177	.7799	.4871
43	.6714	.0949	88	.6879	.2020	133	.7209	.3278	178	.7817	.4914
44	.6717	.0972	89	.6884	.2046	134	.7219	.3309	179	.7835	.4957
45	.6719	.0995	90	.6890	.2071	135	.7229	.3341	180	.7854	.5000

AREAS OF CIRCULAR SEGMENTS

TABLE II, FOR RATIOS OF RISE AND DIAMETER

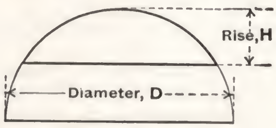


Area = D^2 x Coefficient

H/D	Coefficient	H/D	Coefficient	H/D	Coefficient	H/D	Coefficient	H/D	Coefficient
.001	.000042	.051	.015119	.101	.041477	.151	.074590	.201	.112625
.002	.000119	.052	.015561	.102	.042081	.152	.075307	.202	.113427
.003	.000219	.053	.016008	.103	.042687	.153	.076026	.203	.114231
.004	.000337	.054	.016458	.104	.043296	.154	.076747	.204	.115036
.005	.000471	.055	.016912	.105	.043908	.155	.077470	.205	.115842
.006	.000619	.056	.017369	.106	.044523	.156	.078194	.206	.116651
.007	.000779	.057	.017831	.107	.045140	.157	.078921	.207	.117460
.008	.000952	.058	.018297	.108	.045759	.158	.079650	.208	.118271
.009	.001135	.059	.018766	.109	.046381	.159	.080380	.209	.119084
.010	.001329	.060	.019239	.110	.047006	.160	.081112	.210	.119898
.011	.001533	.061	.019716	.111	.047633	.161	.081847	.211	.120713
.012	.001746	.062	.020197	.112	.048262	.162	.082582	.212	.121530
.013	.001969	.063	.020681	.113	.048894	.163	.083320	.213	.122348
.014	.002199	.064	.021168	.114	.049529	.164	.084060	.214	.123167
.015	.002438	.065	.021660	.115	.050165	.165	.084801	.215	.123988
.016	.002685	.066	.022155	.116	.050805	.166	.085545	.216	.124811
.017	.002940	.067	.022653	.117	.051446	.167	.086290	.217	.125634
.018	.003202	.068	.023155	.118	.052090	.168	.087037	.218	.126459
.019	.003472	.069	.023660	.119	.052737	.169	.087785	.219	.127286
.020	.003749	.070	.024168	.120	.053385	.170	.088536	.220	.128114
.021	.004032	.071	.024680	.121	.054037	.171	.089288	.221	.128943
.022	.004322	.072	.025196	.122	.054690	.172	.090042	.222	.129773
.023	.004619	.073	.025714	.123	.055346	.173	.090797	.223	.130605
.024	.004922	.074	.026236	.124	.056004	.174	.091555	.224	.131438
.025	.005231	.075	.026761	.125	.056664	.175	.092314	.225	.132273
.026	.005546	.076	.027290	.126	.057327	.176	.093074	.226	.133109
.027	.005867	.077	.027821	.127	.057991	.177	.093837	.227	.133946
.028	.006194	.078	.028356	.128	.058658	.178	.094601	.228	.134784
.029	.006527	.079	.028894	.129	.059328	.179	.095367	.229	.135624
.030	.006866	.080	.029435	.130	.059999	.180	.096135	.230	.136465
.031	.007209	.081	.029979	.131	.060673	.181	.096904	.231	.137307
.032	.007559	.082	.030526	.132	.061349	.182	.097675	.232	.138151
.033	.007913	.083	.031077	.133	.062027	.183	.098447	.233	.138996
.034	.008273	.084	.031630	.134	.062707	.184	.099221	.234	.139842
.035	.008638	.085	.032186	.135	.063389	.185	.099997	.235	.140689
.036	.009008	.086	.032746	.136	.064074	.186	.100774	.236	.141538
.037	.009383	.087	.033308	.137	.064761	.187	.101553	.237	.142388
.038	.009764	.088	.033873	.138	.065449	.188	.102334	.238	.143239
.039	.010148	.089	.034441	.139	.066140	.189	.103116	.239	.144091
.040	.010538	.090	.035012	.140	.066833	.190	.103900	.240	.144945
.041	.010932	.091	.035586	.141	.067528	.191	.104686	.241	.145800
.042	.011331	.092	.036162	.142	.068225	.192	.105472	.242	.146656
.043	.011734	.093	.036742	.143	.068924	.193	.106261	.243	.147513
.044	.012142	.094	.037324	.144	.069626	.194	.107051	.244	.148371
.045	.012555	.095	.037909	.145	.070329	.195	.107843	.245	.149231
.046	.012971	.096	.038497	.146	.071034	.196	.108636	.246	.150091
.047	.013393	.097	.039087	.147	.071741	.197	.109431	.247	.150953
.048	.013818	.098	.039681	.148	.072450	.198	.110227	.248	.151816
.049	.014248	.099	.040277	.149	.073162	.199	.111025	.249	.152681
.050	.014681	.100	.040875	.150	.073875	.200	.111824	.250	.153546

AREAS OF CIRCULAR SEGMENTS

TABLE II, FOR RATIOS OF RISE AND DIAMETER—CONCLUDED



Area = D^2 x Coefficient

$\frac{H}{D}$	Coefficient	$\frac{H}{D}$	Coefficient	$\frac{H}{D}$	Coefficient	$\frac{H}{D}$	Coefficient	$\frac{H}{D}$	Coefficient
.251	.154413	.301	.199085	.351	.245935	.401	.294350	.451	.343778
.252	.155281	.302	.200003	.352	.246890	.402	.295330	.452	.344773
.253	.156149	.303	.200922	.353	.247845	.403	.296311	.453	.345768
.254	.157019	.304	.201841	.354	.248801	.404	.297292	.454	.346764
.255	.157891	.305	.202762	.355	.249758	.405	.298274	.455	.347760
.256	.158763	.306	.203683	.356	.250715	.406	.299256	.456	.348756
.257	.159636	.307	.204605	.357	.251673	.407	.300238	.457	.349752
.258	.160511	.308	.205528	.358	.252632	.408	.301221	.458	.350749
.259	.161386	.309	.206452	.359	.253591	.409	.302204	.459	.351745
.260	.162263	.310	.207376	.360	.254551	.410	.303187	.460	.352742
.261	.163141	.311	.208302	.361	.255511	.411	.304171	.461	.353739
.262	.164020	.312	.209228	.362	.256472	.412	.305156	.462	.354736
.263	.164900	.313	.210155	.363	.257433	.413	.306140	.463	.355733
.264	.165781	.314	.211083	.364	.258395	.414	.307125	.464	.356730
.265	.166663	.315	.212011	.365	.259358	.415	.308110	.465	.357728
.266	.167546	.316	.212941	.366	.260321	.416	.309096	.466	.358725
.267	.168431	.317	.213871	.367	.261285	.417	.310082	.467	.359723
.268	.169316	.318	.214802	.368	.262249	.418	.311068	.468	.360721
.269	.170202	.319	.215734	.369	.263214	.419	.312055	.469	.361719
.270	.171090	.320	.216666	.370	.264179	.420	.313042	.470	.362717
.271	.171978	.321	.217600	.371	.265145	.421	.314029	.471	.363715
.272	.172868	.322	.218534	.372	.266111	.422	.315017	.472	.364714
.273	.173758	.323	.219469	.373	.267078	.423	.316005	.473	.365712
.274	.174650	.324	.220404	.374	.268046	.424	.316993	.474	.366711
.275	.175542	.325	.221341	.375	.269014	.425	.317981	.475	.367710
.276	.176436	.326	.222278	.376	.269982	.426	.318970	.476	.368708
.277	.177330	.327	.223216	.377	.270951	.427	.319959	.477	.369707
.278	.178226	.328	.224154	.378	.271921	.428	.320949	.478	.370706
.279	.179122	.329	.225094	.379	.272891	.429	.321938	.479	.371705
.280	.180020	.330	.226034	.380	.273861	.430	.322928	.480	.372704
.281	.180918	.331	.226974	.381	.274832	.431	.323919	.481	.373704
.282	.181818	.332	.227916	.382	.275804	.432	.324909	.482	.374703
.283	.182718	.333	.228858	.383	.276776	.433	.325900	.483	.375702
.284	.183619	.334	.229801	.384	.277748	.434	.326891	.484	.376702
.285	.184522	.335	.230745	.385	.278721	.435	.327883	.485	.377701
.286	.185425	.336	.231689	.386	.279695	.436	.328874	.486	.378701
.287	.186329	.337	.232634	.387	.280669	.437	.329866	.487	.379701
.288	.187235	.338	.233580	.388	.281643	.438	.330858	.488	.380700
.289	.188141	.339	.234526	.389	.282618	.439	.331851	.489	.381700
.290	.189048	.340	.235473	.390	.283593	.440	.332843	.490	.382700
.291	.189956	.341	.236421	.391	.284569	.441	.333836	.491	.383700
.292	.190865	.342	.237369	.392	.285545	.442	.334829	.492	.384699
.293	.191774	.343	.238319	.393	.286521	.443	.335823	.493	.385699
.294	.192685	.344	.239268	.394	.287499	.444	.336816	.494	.386699
.295	.193597	.345	.240219	.395	.288476	.445	.337810	.495	.387699
.296	.194509	.346	.241170	.396	.289454	.446	.338804	.496	.388699
.297	.195423	.347	.242122	.397	.290432	.447	.339799	.497	.389699
.298	.196337	.348	.243074	.398	.291411	.448	.340793	.498	.390699
.299	.197252	.349	.244027	.399	.292390	.449	.341788	.499	.391699
.300	.198168	.350	.244980	.400	.293370	.450	.342783	.500	.392699

RELATIONS IN CIRCULAR SEGMENTS

Central Angle		A/R^2	C/R	H/R	H/C	Central Angle		A/R^2	C/R	H/R	H/C
a° Degree	a_r Radians	Area / Radius^2	Chord / Radius	Height / Radius	Height / Chord	a° Degree	a_r Radians	Area / Radius^2	Chord / Radius	Height / Radius	Height / Chord
1	.017453	.(6)44304	.017453	.(4)38077	.0021817	46	.802851	.0417559	.781462	.0794951	.101726
2	.034907	.(5)35442	.034905	.(3)15230	.0043634	47	.820305	.0444755	.797498	.0829399	.104000
3	.052360	.(4)11961	.052354	.(3)34268	.0065454	48	.837758	.0473066	.813473	.0864545	.106278
4	.069813	.(4)28348	.069799	.(3)60917	.0087275	49	.855211	.0502509	.829386	.0900387	.108561
5	.087266	.(4)55360	.087239	.(3)95178	.0109100	50	.872665	.0533101	.845237	.0936922	.110847
6	.104720	.(4)95646	.104672	.(2)13705	.0130929	51	.890118	.0564860	.861022	.0974147	.113138
7	.122173	.(3)15185	.122097	.(2)18652	.0152764	52	.907571	.0597802	.876742	.101206	.115434
8	.139626	.(3)22662	.139513	.(2)24359	.0174604	53	.925025	.0631945	.892396	.105066	.117734
9	.157080	.(3)32258	.156918	.(2)30827	.0196451	54	.942478	.0667304	.907981	.108994	.120039
10	.174533	.(3)44237	.174311	.(2)38053	.0218305	55	.959931	.0703896	.923497	.112989	.122349
11	.191986	.(3)58861	.191692	.(2)46038	.0240167	56	.977384	.0741734	.938943	.117052	.124664
12	.209440	.(3)76391	.209057	.(2)54781	.0262039	57	.994838	.0780836	.954318	.121183	.126984
13	.226893	.(3)97087	.226406	.(2)64281	.0283921	58	1.012291	.0821215	.969619	.125380	.129309
14	.244346	.(2)12121	.243739	.(2)74538	.0305813	59	1.029744	.0862885	.984847	.129644	.131639
15	.261799	.(2)14902	.261052	.(2)85551	.0327717	60	1.047198	.0905861	1.000000	.133975	.133975
16	.279253	.(2)18077	.278346	.(2)97319	.0349634	61	1.064651	.0950156	1.015077	.138371	.136316
17	.296706	.(2)21671	.295619	.0109841	.0371564	62	1.082104	.0995783	1.030076	.142833	.138662
18	.314159	.(2)25711	.312869	.0123117	.0393509	63	1.099557	.1042754	1.044997	.147360	.141015
19	.331613	.(2)30222	.330095	.0137144	.0415468	64	1.117011	.109108	1.059839	.151952	.143373
20	.349066	.(2)35229	.347296	.0151922	.0437443	65	1.134464	.114078	1.074599	.156609	.145737
21	.366519	.(2)40756	.364471	.0167451	.0459436	66	1.151917	.119186	1.089278	.161329	.148107
22	.383972	.(2)46829	.381618	.0183728	.0481445	67	1.169371	.124433	1.103874	.166114	.150483
23	.401426	.(2)53473	.398736	.0200753	.0503474	68	1.186824	.129820	1.118386	.170962	.152865
24	.418879	.(2)60712	.415823	.0218524	.0525521	69	1.204277	.135348	1.132812	.175874	.155254
25	.436332	.(2)68570	.432879	.0237040	.0547589	70	1.221730	.141019	1.147153	.180848	.157649
26	.453786	.(2)77072	.449902	.0256299	.0569678	71	1.239184	.146833	1.161406	.185885	.160051
27	.471239	.(2)86242	.466891	.0276301	.0591789	72	1.256637	.152790	1.175571	.190983	.162460
28	.488692	.(2)96103	.483844	.0297043	.0613923	73	1.274090	.158893	1.189646	.196143	.164875
29	.506145	.0106680	.500760	.0318524	.0636081	74	1.291544	.165141	1.203630	.201365	.167298
30	.523599	.0117994	.517638	.0340742	.0658263	75	1.308997	.171536	1.217523	.206647	.169727
31	.541052	.0130070	.534477	.0363695	.0680469	76	1.326450	.178077	1.231323	.211989	.172164
32	.558505	.0142931	.551275	.0387383	.0702704	77	1.343904	.184767	1.245029	.217392	.174608
33	.575959	.0156599	.568031	.0411803	.0724966	78	1.361357	.191605	1.258641	.222854	.177059
34	.593412	.0171095	.584743	.0436952	.0747254	79	1.378810	.198591	1.272156	.228375	.179518
35	.610865	.0186444	.601412	.0462830	.0769573	80	1.396263	.205728	1.285575	.233956	.181985
36	.628319	.0202666	.618034	.0489435	.0791922	81	1.413717	.213014	1.298896	.239594	.184460
37	.645772	.0219784	.634609	.0516763	.0814301	82	1.431170	.220451	1.312118	.245290	.186942
38	.663225	.0237818	.651136	.0544814	.0836713	83	1.448623	.228039	1.325240	.251044	.189433
39	.680678	.0256790	.667614	.0573585	.0859157	84	1.466077	.235777	1.338261	.256855	.191932
40	.698132	.0276721	.684040	.0603074	.0881635	85	1.483530	.243668	1.351180	.262723	.194439
41	.715585	.0297630	.700415	.0633278	.0904147	86	1.500983	.251710	1.363997	.268646	.196955
42	.733038	.0319539	.716736	.0664196	.0926696	87	1.518436	.259903	1.376709	.274626	.199480
43	.750492	.0342466	.733002	.0695824	.0949279	88	1.535890	.268249	1.389317	.280660	.202013
44	.767945	.0366433	.749213	.0728161	.0971901	89	1.553343	.276748	1.401819	.286750	.204555
45	.785398	.0391457	.765367	.0761205	.0994562	90	1.570796	.285398	1.414214	.292893	.207107

For angles a° less than 1°: Radians, a_r = .01745329 a°: A/R^2 = .(6)44304 a$^{\circ 3}$
C/R = .0174531 a°: H/R = .000038077 a$^{\circ 2}$
H/C = .00218167 a°.

RELATIONS IN CIRCULAR SEGMENTS

Central Angle		A/R²	C/R	H/R	H/C	Central Angle		A/R²	C/R	H/R	H/C
a° Degree	a_r Radians	Area / Radius²	Chord / Radius	Height / Radius	Height / Chord	a° Degree	a_r Radians	Area / Radius²	Chord / Radius	Height / Radius	Height / Chord
91	1.588250	.294201	1.426501	.299091	.209667	136	2.373648	.839495	1.854368	.625393	.337254
92	1.605703	.303156	1.438680	.305342	.212237	137	2.391101	.854551	1.860835	.633499	.340438
93	1.623156	.312263	1.450749	.311645	.214817	138	2.408554	.869712	1.867161	.641632	.343641
94	1.640609	.321523	1.462707	.318002	.217406	139	2.426008	.884974	1.873344	.649793	.346862
95	1.658063	.330934	1.474555	.324410	.220005	140	2.443461	.900337	1.879385	.657980	.350104
96	1.675516	.340497	1.486290	.330869	.222614	141	2.460914	.915797	1.885283	.666193	.353365
97	1.692969	.350212	1.497911	.337380	.225234	142	2.478368	.931353	1.891037	.674432	.356647
98	1.710423	.360077	1.509419	.343941	.227863	143	2.495821	.947003	1.896647	.682695	.359948
99	1.727876	.370094	1.520812	.350552	.230503	144	2.513274	.962744	1.902113	.690983	.363271
100	1.745329	.380261	1.532089	.357212	.233154	145	2.530727	.978576	1.907434	.699294	.366615
101	1.762783	.390578	1.543249	.363922	.235815	146	2.548181	.994494	1.912610	.707628	.369981
102	1.780236	.401044	1.554292	.370680	.238488	147	2.565634	1.010498	1.917639	.715985	.373368
103	1.797689	.411660	1.565216	.377485	.241171	148	2.583087	1.026584	1.922523	.724363	.376777
104	1.815142	.422423	1.576022	.384339	.243866	149	2.600541	1.042751	1.927261	.732762	.380209
105	1.832596	.433335	1.586707	.391239	.246573	150	2.617994	1.058997	1.931852	.741181	.383664
106	1.850049	.444394	1.597271	.398185	.249291	151	2.635447	1.075319	1.936295	.749620	.387141
107	1.867502	.455599	1.607714	.405177	.252021	152	2.652900	1.091714	1.940591	.758078	.390643
108	1.884955	.466950	1.618034	.412215	.254763	153	2.670354	1.108182	1.944740	.766555	.394168
109	1.902409	.478445	1.628231	.419297	.257517	154	2.687807	1.124718	1.948740	.775049	.397718
110	1.919862	.490085	1.638304	.426424	.260284	155	2.705260	1.141321	1.952592	.783560	.401292
111	1.937315	.501868	1.648252	.433594	.263063	156	2.722714	1.157989	1.956295	.792088	.404892
112	1.954769	.513792	1.658075	.440807	.265855	157	2.740167	1.174718	1.959849	.800632	.408517
113	1.972222	.525859	1.667772	.448063	.268660	158	2.757620	1.191507	1.963254	.809191	.412168
114	1.989675	.538065	1.677341	.455361	.271478	159	2.775074	1.208353	1.966510	.817765	.415846
115	2.007129	.550410	1.686783	.462700	.274309	160	2.792527	1.225253	1.969616	.826352	.419550
116	2.024582	.562894	1.696096	.470081	.277155	161	2.809980	1.242206	1.972571	.834952	.423281
117	2.042035	.575514	1.705280	.477501	.280013	162	2.827433	1.259208	1.975377	.843566	.427040
118	2.059489	.588270	1.714335	.484962	.282886	163	2.844887	1.276258	1.978032	.852191	.430828
119	2.076942	.601161	1.723258	.492462	.285774	164	2.862340	1.293351	1.980536	.860827	.434643
120	2.094395	.614185	1.732051	.500000	.288675	165	2.879793	1.310487	1.982890	.869474	.438488
121	2.111848	.627341	1.740711	.507576	.291591	166	2.897247	1.327662	1.985092	.878131	.442363
122	2.129302	.640627	1.749239	.515190	.294523	167	2.914700	1.344874	1.987144	.886797	.446267
123	2.146755	.654042	1.757634	.522841	.297469	168	2.932153	1.362121	1.989044	.895472	.450202
124	2.164208	.667585	1.765895	.530528	.300430	169	2.949606	1.379399	1.990792	.904154	.454168
125	2.181662	.681255	1.774022	.538251	.303407	170	2.967060	1.396706	1.992389	.912844	.458166
126	2.199115	.695049	1.782013	.546010	.306400	171	2.984513	1.414039	1.993835	.921541	.462195
127	2.216568	.708966	1.789869	.553802	.309409	172	3.001966	1.431397	1.995128	.930244	.466258
128	2.234021	.723005	1.797588	.561629	.312435	173	3.019420	1.448775	1.996270	.938952	.470353
129	2.251475	.737164	1.805171	.569489	.315476	174	3.036873	1.466172	1.997259	.947664	.474482
130	2.268928	.751442	1.812616	.577382	.318535	175	3.054326	1.483585	1.998096	.956381	.478646
131	2.286381	.765836	1.819923	.585307	.321611	176	3.071779	1.501012	1.998782	.965101	.482844
132	2.303835	.780345	1.827091	.593263	.324704	177	3.089233	1.518448	1.999315	.973823	.487078
133	2.321288	.794967	1.834120	.601251	.327814	178	3.106686	1.535893	1.999695	.982548	.491349
134	2.338741	.809701	1.841010	.609269	.330943	179	3.124139	1.553343	1.999924	.991274	.495656
135	2.356194	.824544	1.847759	.617317	.334089	180	3.141593	1.570796	2.000000	1.000000	.500000

VALUES FOR COMBINATIONS OF π

$\pi = 3.14159265359 \quad \log_{10}\pi = 0.4971498726$

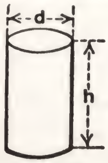
Combination	Values for n								
	1	2	3	4	5	6	7	8	9
$n\pi$	3.141593	6.283185	9.424778	12.566371	15.707963	18.849556	21.991149	25.132741	28.274334
$\frac{n\pi}{4}$	.785398	1.570796	2.356194	3.141593	3.926991	4.712389	5.497787	6.283185	7.068583
$\frac{n\pi}{6}$	.523599	1.047198	1.570796	2.094395	2.617994	3.141593	3.665191	4.188790	4.712389
$\frac{n\pi}{8}$	.392699	.785398	1.178097	1.570796	1.963495	2.356194	2.748894	3.141593	3.534292
$\frac{n\pi}{16}$	.196350	.392699	.589049	.785398	.981748	1.178097	1.374447	1.570796	1.767146
$\frac{n\pi}{32}$	.098175	1.96350	.294524	.392699	.490874	.589049	.687223	.785398	.883573
$\frac{n\pi}{64}$	.049087	.098175	.147262	.196350	.245437	.294524	.343612	.392699	.441786
$\frac{\pi}{n}$	3.141593	1.570796	1.047198	.785398	.628319	.523599	.448799	.392699	.349066
$\frac{n}{\pi}$	.318310	.636620	.954930	1.273240	1.591549	1.909859	2.228169	2.546479	2.864789
$\frac{\pi}{n\,90^\circ}$	.034907	.017453	.011636	.008727	.006981	.005818	.004987	.004363	.003879
$\frac{n\,90^\circ}{\pi}$	28.647890	57.295780	85.943669	114.59156	143.239450	171.88734	200.53523	229.18312	257.83101
π^n	3.141593	9.869604	31.006277	97.409091	306.01968	961.38919	3020.2932	9488.5309	29809.100
$\frac{1}{\pi^n}$	.318310	.101321	.032252	.010266	.003268	.001040	.000331	.000105	.000034
$\sqrt[n]{\pi}$	3.141593	1.772454	1.464592	1.331335	1.257274	1.210203	1.177664	1.153835	1.135635
$\frac{1}{\sqrt[n]{\pi}}$	.318310	.564190	.682784	.751126	.795371	.826307	.849139	.866675	.880564
$n\pi^2$	9.869604	19.739209	29.608813	39.478418	49.348022	59.217626	69.087231	79.956835	88.826439
$\frac{n}{\pi^2}$	.101321	.202642	.303964	.405285	.506606	.607927	.709248	.810569	.911891
$\sqrt{n\pi}$	1.772454	2.506628	3.069980	3.544908	3.963327	4.341608	4.689472	5.013257	5.317362
$\sqrt{\frac{n}{\pi}}$	.564190	.797885	.977205	1.128379	1.261566	1.381977	1.492705	1.595769	1.692569
$n\sqrt{\pi}$	1.772454	3.544908	5.317362	7.089815	8.862269	10.634723	12.407177	14.179631	15.952085
$\frac{n}{\sqrt{\pi}}$	.564190	1.128379	1.692569	2.256758	2.820948	3.385137	3.949327	4.513517	5.077706
$n\pi^3$	31.006277	62.012553	93.018830	124.02511	155.03138	186.03766	217.04394	248.05021	279.05649
$\frac{n}{\pi^3}$	.032252	.064503	.096755	.129006	.161258	.193509	.225761	.258012	.290264
$\sqrt[3]{n\pi}$	1.464592	1.845270	2.112307	2.324895	2.504417	2.661340	2.801664	2.929184	3.046474
$\sqrt[3]{\frac{n}{\pi}}$	.682784	.860254	.984745	1.083852	1.167544	1.240701	1.306119	1.365568	1.420248
$n\sqrt[3]{\pi}$	1.464592	2.929184	4.393776	5.858368	7.322960	8.787551	10.252143	11.716735	13.181327
$\frac{n}{\sqrt[3]{\pi}}$	.6827841	1.3655681	2.0483522	2.7311363	3.4139203	4.096704	4.779489	5.462273	6.145057
$n\pi^4$	97.409091	194.81818	292.22727	389.63636	487.04545	584.45455	681.86364	779.27273	876.68182
$\frac{n}{\pi^4}$	.0102660	.0205320	.0307979	.0410639	.0513299	.061596	.071862	.082128	.092394
$\sqrt[4]{n\pi}$	1.331335	1.583233	1.752136	1.882793	1.990811	2.083653	2.165519	2.239030	2.305940
$\sqrt[4]{\frac{n}{\pi}}$	.751126	.893244	.988537	1.062252	1.123195	1.175575	1.221763	1.263238	1.300988

More accurate values frequently used:

$\frac{\pi}{180} = 0.01745329252$, $\log\frac{\pi}{180} = 8.2418773675 - 10$, $\sqrt{\pi} = 1.772453851$, $\log\sqrt{\pi} = .2485749363$

$\frac{180}{\pi} = 57.29577949$, $\log\frac{180}{\pi} = 1.7581226325$, $\sqrt{\frac{1}{\pi}} = 0.5641895835$, $\log\sqrt{\frac{1}{\pi}} = 9.7514250637 - 10$

SURFACES AND VOLUMES OF SOLIDS



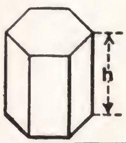
CYLINDER

Convex Surface $= \pi dh$

Total Surface $= \pi dh + \frac{\pi d^2}{2}$

Volume $= \frac{\pi}{4} d^2 h$

Volume Cylinder, right or oblique = area of section at right angles to sides $\times$ length of side.

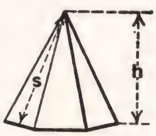


PRISM

Lateral Surface $= h \times$ Base Perimeter

Total Surface = Lateral Surface + (2 $\times$ Base Area)

Volume $= h \times$ Base Area



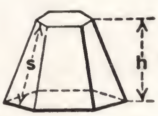
PYRAMID

Lateral Surface $= \frac{s}{2} \times$ Base Perimeter

Total Surface = Lateral Surface + Base Area

Volume $= \frac{h}{3} \times$ Base Area

Center of Gravity $= \frac{h}{4}$, above base



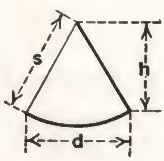
FRUSTUM OF PYRAMID

Lateral Surface = s(Top + Base Perimeters) $\div$ 2
If a = top area and A = base area,

Total Surface = Lateral Surface + (a + A)

Volume $= h(a + A + \sqrt{aA}) \div 3$

Center of Gravity above base $= \frac{h}{4}\left(\frac{3a + A + 2\sqrt{aA}}{a + A + \sqrt{aA}}\right)$



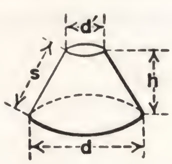
CONE

Convex Surface $= \frac{\pi}{2} ds = \frac{\pi d}{4} \sqrt{d^2 + 4h^2}$

Total Surface = Convex Surface $+ \frac{\pi d^2}{4}$

Volume $= \frac{\pi}{12} d^2 h = \frac{\pi}{24} d^2 \sqrt{4s^2 - d^2}$

Center of Gravity above base $= \frac{h}{4}$



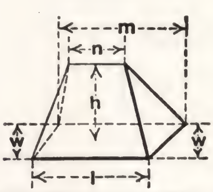
FRUSTUM OF CONE

Convex Surface $= \frac{\pi s}{2} (d + d') = \frac{\pi}{4} (d + d') \sqrt{4h^2 + (d - d')^2}$

Total Surface $= \frac{\pi s}{2} (d + d') + \frac{\pi}{4} (d^2 + d'^2)$

Volume $= \frac{\pi h}{12} (d^2 + dd' + d'^2)$

Center of Gravity above base $= \frac{h(d^2 + 2dd' + 3d'^2)}{4(d^2 + dd' + d'^2)}$

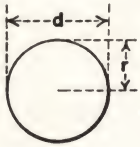


WEDGE

Surface = Sum of surfaces of bounding planes

Volume $= \frac{wh}{6} (l + m + n)$

SURFACES AND VOLUMES OF SOLIDS



SPHERE

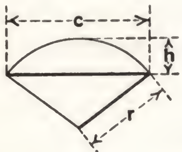
Surface $= \pi d^2 = 4\pi r^2$

Volume $= \frac{\pi d^3}{6} = \frac{4}{3}\pi r^3$

Side of an equal cube = diameter of sphere $\times$ 0.806

Length of an equal cylinder = diameter of sphere $\times$ 0.6667

Center of Gravity of Half Sphere = $\frac{3}{8}r$ above spherical center

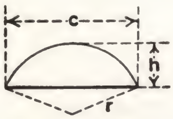


SPHERICAL SECTOR

Total Surface $= \frac{\pi r}{2}(4h + c)$

Volume $= \frac{2}{3}\pi r^2 h = \frac{2}{3}\pi r^2\left(r - \sqrt{r^2 - \frac{c^2}{4}}\right)$

Center of Gravity above center of sphere $= \frac{3}{4}\left(r - \frac{h}{2}\right)$



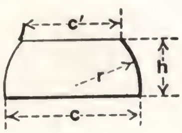
SPHERICAL SEGMENT

Spherical Surface $= 2\pi rh = \pi(c^2 + 4h^2) \div 4$

Total Surface = Spherical Surface $+ (\pi c^2 \div 4)$

Volume $= \pi h^2(3r - h) \div 3 = \pi h(3c^2 + 4h^2) \div 24$

Center of gravity above base of segment
$= h(4r - h) \div 4(3r - h)$

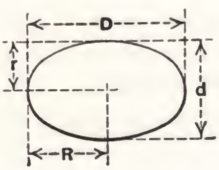


SPHERICAL ZONE

Convex Surface $= 2\pi rh$

Total Surface $= 2\pi rh + \frac{\pi}{4}(c^2 + c'^2)$

Volume $= \frac{\pi h}{24}(3c^2 + 3c'^2 + 4h^2)$



ELLIPSOID (I. Revolution about transverse axis)

Surface $= 2\pi r\left[r + R\left(\frac{\sin^{-1} e}{e}\right)\right]$

Volume $= \frac{4}{3}\pi R r^2$

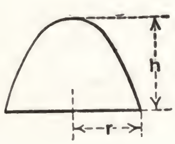
$\sin^{-1} e$ = Angle, in radians, whose sine = e

ELLIPSOID (II. Revolution about conjugate axis)

Surface $= \pi\left[2R^2 + \frac{2.303r^2}{e}\log.\left(\frac{1+e}{1-e}\right)\right]$

Volume $= \frac{4}{3}\pi R^2 r$ Where $e = \frac{\sqrt{R^2 - r^2}}{R}$

Use common, or base 10, log.



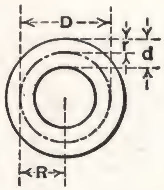
PARABOLOID

Convex Surface $= \frac{\pi r}{6h^2}\left[(r^2 + 4h^2)^{3/2} - r^3\right]$

Total Surface = Convex Surface $+ \pi r^2$

Volume $= \frac{\pi r^2 h}{2}$ Center of Gravity $= \frac{h}{3}$ above base

SURFACES AND VOLUMES OF SOLIDS



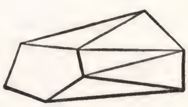
CIRCULAR RING (TORUS)

D and R = Mean Diameter and Mean Radius, respectively, of Ring

d and r = Mean Diameter and Mean Radius, respectively, of Section

Surface $= \pi^2 Dd = 4\pi^2 Rr$

Volume $= 2\pi^2 Rr^2 = \dfrac{\pi^2}{4} Dd^2$



PRISMOID

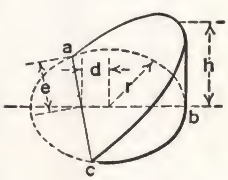
End faces are in parallel planes.

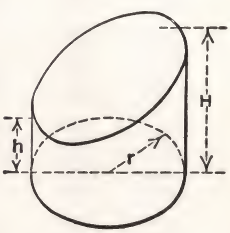
Volume $= \dfrac{l}{6}(A + A' + 4M)$, where

l = perpendicular distance between ends

A,A′ = areas of ends

M = area of mid section, parallel to ends





UNGULAS FROM RIGHT CIRCULAR CYLINDER

(As formed by cutting plane oblique to base)

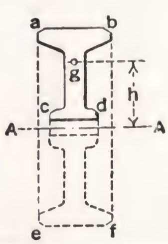
I. Base, abc, less than semicircle;
Convex Surface
$= h[2re - (d \times \text{length arc abc})] \div (r - d)$
Volume $= h\left[\dfrac{2}{3}e^3 - (d \times \text{area base abc})\right] \div (r - d)$

II. Base, abc = semicircle;
Convex Surface $= 2rh$ Volume $= \frac{2}{3}r^2h$

III. Base, abc, greater than semicircle (figure)
Convex Surface
$= h[2re + (d \times \text{length arc abc})] \div (r + d)$
Volume $= h\left[\dfrac{2}{3}e^3 + (d \times \text{area base abc})\right] \div (r + d)$

IV. Base, abc, = circle, oblique plane touching circumference.
Convex Surface $= \pi rh$ Volume $= \frac{1}{2}\pi r^2h$

V. Base, abc, = circle, oblique plane entirely above (figure)
Convex Surface $= 2\pi r$
$\times \frac{1}{2}$(h, minimum + H, maximum)
Volume $= \pi r^2 \times \frac{1}{2}$(h, minimum + H, maximum)



ANY SOLID OF REVOLUTION

Let abcd represent the generating section about axis A-A of solid abef.

Let g at distance h from A-A be the center of gravity of abcd.

Let $\alpha°$ be the angular amount of generating revolution.

Then
Total Surface of solid abef
$= (2\pi h\alpha \div 360) \times$ perimeter abcd

Volume of solid abef $= (2\pi h\alpha \div 360) \times$ area abcd

For complete revolution $(2\pi h\alpha \div 360) = 2\pi h$

WIRE AND SHEET METAL GAGES

IN DECIMALS OF AN INCH

Name of Gage	United States Standard Gage* U. S. Std.		Birmingham (or Stubs Iron) Wire Gage B.W.G.	New Birmingham Standard Sheet and Hoop Gage B.G.	American or Browne & Sharpe Wire Gage B. & S.	United States Steel Wire formerly Washburn & Moen†	British Imperial or English Legal Standard Wire Gage S. W. G.	American Screw Co. Screw Wire Gage	Name of Gage
Principal Use	Uncoated Steel Sheets and Light Plates		Strips, Bands, Hoops and Wire	Iron and Steel Sheets and Hoops	Non-Ferrous Sheets and Wire	Steel Wire except Music Wire	Wire		Principal Use
Gage No.	Weight, Pounds per Sq. Ft.	Thickness, Inches	Thickness or Diameter, Inches						Gage No.
7-0s	20.00	.4902	......	.6666	....	.4900	.500	......	7-0s
6-0s	18.75	.4596	......	.6250	.580000	.4615	.464	......	6-0s
5-0s	17.50	.4289	.500	.5883	.516500	.4305	.432	......	5-0s
4-0s	16.25	.3983	.454	.5416	.460000	.3938	.400	......	4-0s
3-0s	15.00	.3676	.425	.5000	.409642	.3625	.372	.0315	3-0s
2-0s	13.75	.3370	.380	.4452	.364796	.3310	.348	.0447	2-0s
1-0	12.50	.3064	.340	.3964	.324861	.3065	.324	.0578	1-0
1	11.25	.2757	.300	.3532	.289297	.2830	.300	.0710	1
2	10.625	.2604	.284	.3147	.257627	.2625	.276	.0842	2
3	10.00	.2451	.259	.2804	.229423	.2437	.252	.0973	3
4	9.375	.2298	.238	.2500	.204307	.2253	.232	.1105	4
5	8.750	.2145	.220	.2225	.181940	.2070	.212	.1236	5
6	8.125	.1991	.203	.1981	.162023	.1920	.192	.1368	6
7	7.500	.1838	.180	.1764	.144285	.1770	.176	.1500	7
8	6.875	.1685	.165	.1570	.128490	.1620	.160	.1631	8
9	6.250	.1532	.148	.1398	.114423	.1483	.144	.1763	9
10	5.625	.1379	.134	.1250	.101897	.1350	.128	.1894	10
11	5.000	.1225	.120	.1113	.090742	.1205	.116	.2026	11
12	4.375	.1072	.109	.0991	.080808	.1055	.104	.2158	12
13	3.750	.0919	.095	.0882	.071962	.0915	.092	.2289	13
14	3.125	.0766	.083	.0785	.064084	.0800	.080	.2421	14
15	2.8125	.0689	.072	.0699	.057068	.0720	.072	.2552	15
16	2.500	.0613	.065	.0625	.050821	.0625	.064	.2684	16
17	2.250	.0551	.058	.0556	.045257	.0540	.056	.2816	17
18	2.000	.0490	.049	.0495	.040303	.0475	.048	.2947	18
19	1.750	.0429	.042	.0440	.035890	.0410	.040	.3079	19
20	1.500	.0368	.035	.0392	.031961	.0348	.036	.3210	20
21	1.375	.0337	.032	.0349	.028462	.03175	.032	.3342	21
22	1.250	.0306	.028	.03125	.025346	.0286	.028	.3474	22
23	1.125	.0276	.025	.02782	.022572	.0258	.024	.3605	23
24	1.000	.0245	.022	.02476	.020101	.0230	.022	.3737	24
25	.875	.0214	.020	.02204	.017900	.0204	.020	.3868	25
26	.750	.0184	.018	.01961	.015941	.0181	.018	.4000	26
27	.6875	.0169	.016	.01745	.014195	.0173	.0164	.4132	27
28	.625	.0153	.014	.015625	.012641	.0162	.0148	.4263	28
29	.5625	.0138	.013	.0139	.011257	.0150	.0136	.4395	29
30	.5000	.0123	.012	.0123	.010025	.0140	.0124	.4526	30
31	.4375	.0107	.010	.0110	.008928	.0132	.0116	.4658	31
32	.4062	.0100	.009	.0098	.007950	.0128	.0108	.4790	32
33	.3750	.0092	.008	.0087	.007080	.0118	.0100	.4921	33
34	.3438	.0084	.007	.0077	.006305	.0104	.0092	.5053	34
35	.3125	.0077	.005	.0069	.005615	.0095	.0084	.5184	35
36	.2812	.0069	.004	.0061	.005000	.0090	.0076	.5316	36
37	.2656	.0065	......	.0054	.004453	.0085	.0068	.5448	37
38	.2500	.0061	......	.0048	.003965	.0080	.0060	.5579	38
39	.2344	.0057	......	.0043	.003531	.0075	.0052	.5711	39
40	.2188	.0054	......	.00386	.003144	.0070	.0048	.5842	40

*U. S. Standard Gage is officially a weight gage (in ounces per sq. ft.) based on wrought iron at 480 lb. per cu. ft. The values tabulated above give the thickness of steel (at 489.6 lb. per cu. ft.) that will approximate the respective weights. The other gages are officially thickness gages.

†Also American Steel & Wire Co. and John A. Roebling Co. gages.

PRINCIPAL WIRE GAGES

COMBINED TABLES OF SIZES

Values rounded to 4 significant figures, except column headed "Diameter, inches."

Diameter			Wire Gage Number					Cross Section			
Mils	Mm.	Ins.	B. & S.	W. & M.	B. W. G.	S. W. G.	Metric	Square Inches	Square Mils	Circular Mils	Square Mm.
500	12.70	.500				7/0		.1963	196 300	250 000	126.7
490	12.45	.490		7/0				.1886	188 600	240 100	121.7
464	11.79	.464				6/0		.1691	169 100	215 300	109.1
461.5	11.70	.4615		6/0				.1673	167 300	213 000	107.9
460	11.68	.460	4/0					.1662	166 200	211 600	107.2
454	11.53	.454			4/0			.1619	161 900	206 100	104.4
432	10.97	.432				5/0		.1466	146 600	186 600	94.56
430.5	10.93	.4305		5/0				.1456	145 600	185 300	93.91
425	10.80	.425			3/0			.1419	141 900	180 600	91.52
409.6	10.40	.410	3/0					.1318	131 800	167 800	85.03
400	10.16	.400				4/0		.1257	125 700	160 000	81.07
393.8	10.00	.3938		4/0				.1218	121 800	155 100	78.58
393.7	10.0	.3937					100	.1217	121 700	155 000	78.54
380	9.652	.380			2/0			.1134	113 400	144 400	73.17
372	9.449	.372				3/0		.1087	108 700	138 400	70.12
364.8	9.266	.365	2/0					.1045	104 500	133 100	67.43
362.5	9.208	.3625		3/0				.1032	103 200	131 400	66.58
354.3	9.0	.354					90	.09861	98 610	125 500	63.62
348	8.839	.348				2/0		.09511	95 110	121 100	61.36
340	8.636	.340			0			.09079	90 790	115 600	58.58
331	8.407	.331		2/0				.08605	86 050	109 600	55.52
324.9	8.251	.325	0					.08289	82 890	105 500	53.48
324	8.230	.324				0		.08245	82 450	105 000	53.19
315	8.0	.315					80	.07791	77 910	99 200	50.27
306.5	7.785	.3065		0				.07378	73 780	93 940	47.60
300	7.620	.300			1	1		.07069	70 690	90 000	45.60
289.3	7.348	.289	1					.06573	65 730	83 690	42.41
284	7.214	.284			2			.06335	63 350	80 660	40.87
283	7.188	.283		1				.06290	62 900	80 090	40.58
276	7.010	.276				2		.05983	59 830	76 180	38.60
275.6	7.0	.276					70	.05965	59 650	75 950	38.48
262.5	6.668	.2625		2				.05412	54 120	68 910	34.92
259	6.579	.259			3			.05269	52 690	67 080	33.99
257.6	6.544	.258	2					.05213	52 130	66 370	33.63
252	6.401	.252				3		.04988	49 880	63 500	32.18
243.7	6.190	.2437		3				.04664	46 640	59 390	30.09
238	6.045	.238			4			.04449	44 490	56 640	28.70
236.2	6.0	.236					60	.04383	43 830	55 800	28.27
232	5.893	.232				4		.04227	42 270	53 820	27.27
229.4	5.827	.229	3					.04134	41 340	52 630	26.67
225.3	5.723	.2253		4				.03987	39 870	50 760	25.72
220	5.588	.220			5			.03801	38 010	48 400	24.52
212	5.385	.212				5		.03530	35 300	44 940	22.77
207	5.258	.207		5				.03365	33 650	42 850	21.71
204.3	5.189	.204	4					.03278	32 780	41 740	21.15

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PRINCIPAL WIRE GAGES

COMBINED TABLES OF SIZES

Values rounded to 4 significant figures, except column headed "Diameter, inches."

Diameter			Wire Gage Number					Cross Section			
Mils	Mm.	Ins.	B. & S.	W. & M.	B.W. G.	S. W. G.	Metric	Square Inches	Square Mils	Circular Mils	Square Mm.
203	5.156	.203			6			.032 37	32 370	41 210	20.88
196.8	5.0	.197					50	.030 43	30 430	38 750	19.63
192	4.877	.192		6		6		.028 95	28 950	36 860	18.68
181.9	4.621	.182	5					.026 00	26 000	33 100	16.77
180	4.572	.180			7			.025 45	25 450	32 400	16.42
177.2	4.5	.177					45	.024 65	24 650	31 390	15.90
177	4.496	.177		7				.024 61	24 610	31 330	15.87
176	4.470	.176				7		.024 33	24 330	30 980	15.70
165	4.191	.165			8			.021 38	21 380	27 220	13.80
162	4.115	.162	6	8				.020 62	20 620	26 250	13.30
160	4.064	.160				8		.020 11	20 110	25 600	12.97
157.5	4.0	.157					40	.019 48	19 480	24 810	12.57
148.3	3.767	.1483		9				.017 27	17 270	21 990	11.14
148	3.759	.148			9			.017 20	17 200	21 900	11.10
144.3	3.665	.144	7					.016 35	16 350	20 820	10.55
144	3.658	.144				9		.016 29	16 290	20 740	10.51
137.8	3.5	.138					35	.014 91	14 910	18 990	9.621
135	3.429	.135		10				.014 31	14 310	18 220	9.235
134	3.404	.134			10			.014 10	14 100	17 960	9.098
128.5	3.264	.128	8					.012 97	12 970	16 510	8.366
128	3.251	.128				10		.012 87	12 870	16 380	8.302
120.5	3.061	.1205		11				.011 40	11 400	14 520	7.358
120	3.048	.120			11			.011 31	11 310	14 400	7.297
118.1	3.0	.118					30	.010 96	10 960	13 950	7.069
116	2.946	.116				11		.010 57	10 570	13 460	6.818
114.4	2.906	.114	9					.010 28	10 280	13 090	6.634
109	2.769	.109			12			.009 331	9331	11 880	6.020
105.5	2.680	.1055		12				.008 742	8742	11 130	5.640
104	2.642	.104				12		.008 495	8495	10 820	5.481
101.9	2.588	.102	10					.008 155	8155	10 380	5.261
98.42	2.5	.098					25	.007 609	7609	9687	4.909
95	2.413	.095			13			.007 088	7088	9025	4.573
92	2.337	.092				13		.006 648	6648	8464	4.289
91.5	2.324	.0915		13				.006 576	6576	8372	4.242
90.74	2.305	.091	11					.006 467	6467	8234	4.172
83	2.108	.083			14			.005 411	5411	6889	3.491
80.81	2.053	.081	12					.005 129	5129	6530	3.309
80	2.032	.080		14		14		.005 027	5027	6400	3.243
78.74	2.0	.079					20	.004 869	4869	6200	3.142
72	1.829	.072		15	15	15		.004 072	4072	5184	2.627
71.96	1.828	.072	13					.004 067	4067	5178	2.624
70.87	1.8	.071					18	.003 944	3944	5022	2.545
65	1.651	.065			16			.003 318	3318	4225	2.141
64.08	1.628	.064	14					.003 225	3225	4107	2.081
64	1.626	.064				16		.003 217	3217	4096	2.075

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PRINCIPAL WIRE GAGES

COMBINED TABLES OF SIZES

Values rounded to 4 significant figures, except column headed "Diameter, inches."

Diameter			Wire Gage Number					Cross Section			
Mils	Mm.	Ins.	B. & S.	W. & M.	B. W. G.	S. W. G.	Metric	Square Inches	Square Mils	Circular Mils	Square Mm.
62.99	1.6	.063	......	......	......	......	16	.003 116	3116	3968	2.011
62.5	1.588	.0625	......	16	......	......	......	.003 068	3068	3906	1.979
58	1.473	.058	......	......	17	......	......	.002 642	2642	3364	1.705
57.07	1.450	.057	15	......	......	......	......	.002 558	2558	3257	1.650
56	1.422	.056	......	......	......	17	......	.002 463	2463	3136	1.589
55.12	1.4	.055	......	......	......	......	14	.002 386	2386	3038	1.539
54	1.372	.054	......	17	......	......	......	.002 290	2290	2916	1.478
50.82	1.291	.051	16	......	......	......	......	.002 028	2028	2583	1.309
49	1.245	.049	......	......	18	......	......	.001 886	1886	2401	1.217
48	1.219	.048	......	......	......	18	......	.001 810	1810	2304	1.167
47.5	1.207	.0475	......	18	......	......	......	.001 772	1772	2256	1.143
47.24	1.2	.047	......	......	......	......	12	.001 753	1753	2232	1.131
45.26	1.150	.045	17	......	......	......	......	.001 609	1609	2048	1.038
42	1.067	.042	......	......	19	......	......	.001 385	1385	1764	.8938
41	1.041	.041	......	19	......	......	......	.001 320	1320	1681	.8518
40.3	1.024	.040	18	......	......	......	......	.001 276	1276	1624	.8231
40	1.016	.040	......	......	......	19	......	.001 257	1257	1600	.8107
39.37	1.0	.039	......	......	......	......	10	.001 217	1217	1550	.7854
36	.9144	.036	......	......	......	20	......	.001 018	1018	1296	.6567
35.89	.9116	.036	19	......	......	......	......	.001 012	1012	1288	.6527
35.43	.90	.035	......	......	......	......	9	$.0_39861$	986.1	1255	.6362
35	.8890	.035	......	......	20	......	......	$.0_39621$	962.1	1225	.6207
34.8	.8839	.0348	......	20	......	......	......	$.0_39511$	951.1	1211	.6136
32	.8128	.032	......	......	21	21	......	$.0_38042$	804.2	1024	.5189
31.96	.8118	.032	20	......	......	......	......	$.0_38023$	802.3	1022	.5176
31.7	.8052	.0317	......	21	......	......	......	$.0_37892$	789.2	1005	.5092
31.5	.80	.031	......	......	......	......	8	$.0_37791$	779.1	992	.5027
28.6	.7264	.0286	......	22	......	......	......	$.0_36424$	642.4	818	.4145
28.46	.7229	.0285	21	......	......	......	......	$.0_36363$	636.3	810.1	.4105
28	.7112	.028	......	......	22	22	......	$.0_36158$	615.8	784	.3973
27.56	.70	.0276	......	......	......	......	7	$.0_35965$	596.5	759.5	.3848
25.8	.6553	.0258	......	23	......	......	......	$.0_35228$	522.8	665.6	.3373
25.35	.6438	.0253	22	......	......	......	......	$.0_35046$	504.6	642.4	.3255
25	.6350	.025	......	......	23	......	......	$.0_34909$	490.9	625	.3167
24	.6096	.024	......	......	......	23	......	$.0_34524$	452.4	576	.2919
23.62	.60	.0236	......	......	......	......	6	$.0_34383$	438.3	558	.2827
23	.5842	.023	......	24	......	......	......	$.0_34155$	415.5	529	.2675
22.57	.5733	.0226	23	......	......	......	......	$.0_34001$	400.1	509.5	.2582
22	.5588	.022	......	......	24	24	......	$.0_33801$	380.1	484	.2452
20.4	.5182	.0204	......	25	......	......	......	$.0_33269$	326.9	416.2	.2109
20.1	.5106	.0201	24	......	......	......	......	$.0_33173$	317.3	404	.2047
20	.5080	.020	......	......	25	25	......	$.0_33142$	314.2	400	.2027
19.68	.50	.0197	......	......	......	......	5	$.0_33043$	304.3	387.5	.1963
18.1	.4597	.0181	......	26	......	......	......	$.0_32573$	257.3	327.6	.1660
18	.4572	.018	......	......	26	26	......	$.0_32545$	254.5	324	.1642

$.0_3 = .000$ For example, $.0_39861 = .0009861$
1 Mil = 0.001 inch; 1 Square Mil = .000,001 sq. in.; 1 Circular Mil = Area of Wire 1 Mil in Diameter = .000,0007854 sq. in.; B. & S. = Browne & Sharpe Gage; W. & M. = Washburn & Moen, or United States Steel Wire, or American Steel & Wire Co., or John A. Roebling Sons Co. Gage; B. W. G. = Birmingham Wire, or Stubs Iron Wire Gage; S. W. G. = British Standard Wire Gage; Metric = Millimeter Diameter Gage.

PRINCIPAL WIRE GAGES

COMBINED TABLES OF SIZES

Values rounded to 4 significant figures, except column headed "Diameter, inches."

Diameter			Wire Gage Number					Cross Section			
Mils	Mm.	Ins.	B. & S.	W. & M.	B. W. G.	S. W. G.	Metric	Square Inches	Square Mils	Circular Mils	Square Mm.
17.9	.4547	.0179	25					$.0_3 2517$	251.7	320.4	.1624
17.72	.45	.0177					4.5	$.0_3 2465$	246.5	313.9	.1590
17.3	.4394	.0173		27				$.0_3 2351$	235.1	299.3	.1517
16.4	.4166	.0164				27		$.0_3 2112$	211.2	269	.1363
16.2	.4115	.0162		28				$.0_3 2061$	206.1	262.4	.1330
16	.4064	.016			27			$.0_3 2011$	201.1	256	.1297
15.94	.4049	.0159	26					$.0_3 1996$	199.6	254.1	.1288
15.75	.40	.0157					4	$.0_3 1948$	194.8	248	.1257
15	.3810	.015		29				$.0_3 1767$	176.7	225	.1140
14.8	.3759	.0148				28		$.0_3 1720$	172.0	219	.1110
14.2	.3606	.0142	27					$.0_3 1583$	158.3	201.5	.1021
14	.3556	.0140		30	28			$.0_3 1539$	153.9	196	.099 32
13.78	.35	.0138					3.5	$.0_3 1491$	149.1	189.9	.096 21
13.6	.3454	.0136				29		$.0_3 1453$	145.3	185	.093 72
13.2	.3353	.0132		31				$.0_3 1368$	136.8	174.2	.088 29
13	.3302	.0130			29			$.0_3 1327$	132.7	169	.085 63
12.8	.3251	.0128		32				$.0_3 1287$	128.7	163.8	.083 02
12.64	.3211	.0126	28					$.0_3 1255$	125.5	159.8	.080 98
12.4	.3150	.0124				30		$.0_3 1208$	120.8	153.8	.077 91
12	.3048	.0120			30			$.0_3 1131$	113.1	144	.072 97
11.81	.30	.0118					3	$.0_3 1096$	109.6	139.5	.070 69
11.8	.2997	.0118		33				$.0_3 1094$	109.4	139.2	.070 55
11.6	.2946	.0116				31		$.0_3 1057$	105.7	134.6	.068 18
11.26	.2859	.0113	29					$.0_4 9954$	99.54	126.7	.064 22
10.8	.2743	.0108				32		$.0_4 9161$	91.61	116.6	.059 10
10.4	.2642	.0104		34				$.0_4 8495$	84.95	108.2	.054 81
10.03	.2546	.0100	30					$.0_4 7894$	78.94	100.5	.050 93
10	.2540	.0100			31	33		$.0_4 7854$	78.54	100	.050 67
9.842	.25	.0098					2.5	$.0_4 7609$	76.09	96.87	.049 09
9.5	.2413	.0095		35				$.0_4 7088$	70.88	90.25	.045 73
9.2	.2337	.0092				34		$.0_4 6648$	66.48	84.64	.042 89
9	.2286	.0090		36	32			$.0_4 6362$	63.62	81	.041 04
8.928	.2268	.0089	31					$.0_4 6260$	62.60	79.7	.040 39
8.5	.2159	.0085		37				$.0_4 5675$	56.75	72.25	.036 61
8.4	.2134	.0084				35		$.0_4 5542$	55.42	70.56	.035 75
8	.2032	.0080		38	33			$.0_4 5027$	50.27	64	.032 43
7.95	.2019	.0080	32					$.0_4 4964$	49.64	63.21	.032 03
7.874	.20	.0079					2	$.0_4 4869$	48.69	62.00	.031 42
7.6	.1930	.0076				36		$.0_4 4536$	45.36	57.76	.029 27
7.5	.1905	.0075		39				$.0_4 4418$	44.18	56.25	.028 50
7.087	.18	.0071					1.8	$.0_4 3944$	39.44	50.22	.025 45
7.08	.1798	.0071	33					$.0_4 3937$	39.37	50.13	.025 40
7	.1778	.0070		40	34			$.0_4 3848$	38.48	49	.024 83
6.8	.1727	.0068				37		$.0_4 3632$	36.32	46.24	.023 43
6.6	.1676	.0066		41				$.0_4 3421$	34.21	43.56	.022 07

$.0_3$ = .000 For example, $.0_3 2517$ = .0002517

1 Mil = 0.001 inch; 1 Square Mil = .000,001 sq. in.; 1 Circular Mil = Area of Wire 1 Mil in Diameter = .000,0007854 sq. in.; B. & S. = Browne & Sharpe Gage; W. & M. = Washburn & Moen, or United States Steel Wire, or American Steel & Wire Co., or John A. Roebling Sons Co. Gage; B. W. G. = Birmingham Wire, or Stubs Iron Wire Gage; S. W. G. = British Standard Wire Gage; Metric = Millimeter Diameter Gage.

PRINCIPAL WIRE GAGES

COMBINED TABLES OF SIZES

Values rounded to 4 significant figures, except column headed "Diameter, inches."

Diameter			Wire Gage Number					Cross Section			
Mils	Mm.	Ins.	B. & S.	W. & M.	B. W. G.	S. W. G.	Metric	Square Inches	Square Mils	Circular Mils	Square Mm.
6.305	.1601	.0063	34	......	......	......	......	$.0_43122$	31.22	39.75	.020 14
6.299	.16	.0063	......	......	......	......	1.6	$.0_43116$	31.16	39.68	.020 11
6.2	.1575	.0062	......	42	......	......	......	$.0_43019$	30.19	38.44	.019 48
6	.1524	.0060	......	43	......	38	......	$.0_42827$	28.27	36	.018 24
5.906	.15	.0059	......	......	......	......	1.5	$.0_42739$	27.39	34.87	.017 67
5.8	.1473	.0058	......	44	......	......	......	$.0_42642$	26.42	33.64	.017 05
5.615	.1426	.0056	35	......	......	......	......	$.0_42476$	24.76	31.52	.015 97
5.512	.14	.0055	......	......	......	......	1.4	$.0_42386$	23.86	30.38	.015 39
5.5	.1397	.0055	......	45	......	......	......	$.0_42376$	23.76	30.25	.015 33
5.2	.1321	.0052	......	46	......	39	......	$.0_42124$	21.24	27.04	.013 70
5	.1270	.0050	36	47	35	......	......	$.0_41963$	19.63	25	.012 67
4.8	.1219	.0048	......	48	......	40	......	$.0_41810$	18.10	23.04	.011 67
4.724	.12	.0047	......	......	......	......	1.2	$.0_41753$	17.53	22.32	.011 31
4.6	.1168	.0046	......	49	......	......	......	$.0_41662$	16.62	21.16	.010 72
4.453	.1131	.0045	37	......	......	......	......	$.0_41557$	15.57	19.83	.010 05
4.4	.1118	.0044	......	50	......	41	......	$.0_41521$	15.21	19.36	.009 810
4	.1016	.0040	......	......	36	42	......	$.0_41257$	12.57	16	.008 107
3.965	.1007	.0040	38	......	......	......	......	$.0_41235$	12.35	15.72	.007 967
3.937	.10	.0039	......	......	......	......	1	$.0_41217$	12.17	15.50	.007 854
3.6	.091 44	.0036	......	......	......	43	......	$.0_41018$	10.18	12.96	.006 567
3.531	.089 69	.0035	39	......	......	......	......	$.0_59793$	9.793	12.47	.006 318
3.2	.081 28	.0032	......	......	......	44	......	$.0_58042$	8.042	10.24	.005 189
3.145	.079 87	.0031	40	......	......	......	......	$.0_57766$	7.766	9.888	.005 010
2.800	.071 13	.0028	41	......	......	......	......	$.0_56159$	6.159	7.842	.003 973
2.8	.071 12	.0028	......	......	......	45	......	$.0_56158$	6.158	7.84	.003 973
2.494	.063 34	.0025	42	......	......	......	......	$.0_54884$	4.884	6.219	.003 151
2.4	.060 96	.0024	......	......	......	46	......	$.0_54524$	4.524	5.76	.002 919
2.221	.056 41	.0022	43	......	......	......	......	$.0_53873$	3.873	4.932	.002 499
2	.050 80	.0020	......	......	......	47	......	$.0_53142$	3.142	4	.002 027
1.978	.050 23	.0020	44	......	......	......	......	$.0_53072$	3.072	3.911	.001 982
1.969	.05	.0020	......	......	......	......	0.5	$.0_53044$	3.044	3.875	.001 963
1.761	.044 73	.0018	45	......	......	......	......	$.0_52436$	2.436	3.102	.001 572
1.6	.040 64	.0016	......	......	......	48	......	$.0_52011$	2.011	2.560	.001 297
1.568	.039 84	.0016	46	......	......	......	......	$.0_51932$	1.932	2.460	.001 246
1.397	.035 47	.0014	47	......	......	......	......	$.0_51532$	1.532	1.951	$.0_39884$
1.243	.031 59	.0012	48	......	......	......	......	$.0_51215$	1.215	1.547	$.0_37838$
1.2	.030 48	.0012	......	......	......	49	......	$.0_51131$	1.131	1.44	$.0_37297$
1.107	.028 13	.0011	49	......	......	......	......	$.0_69635$	.9635	1.227	$.0_36216$
1	.025 40	.0010	......	......	......	50	......	$.0_67854$	.7854	1	$.0_35067$
.9863	.025 05	.0010	50	......	......	......	......	$.0_67641$	.7641	.9728	$.0_34929$

$.0_4 = .0000$ For example, $.0_43122 = .00003122$

1 Mil = 0.001 inch; 1 Square Mil = .000,001 sq. in.; 1 Circular Mil = Area of Wire 1 Mil in Diameter = .000,0007854 sq. in.; B. & S. = Browne & Sharpe Gage; W. & M. = Washburn & Moen, or United States Steel Wire, or American Steel & Wire Co., or John A. Roebling Sons Co. Gage; B. W. G. = Birmingham Wire, or Stubs Iron Wire Gage; S. W. G. = British Standard Wire Gage; Metric = Millimeter Diameter Gage.

1.00 to 2.50″
(0.100 to 0.250″)
(10.0 to 25.0″)

REVOLUTIONS PER MINUTE FOR ASSIGNED SURFACE SPEEDS

Diameter D	Circumference		S=Surface Speeds, Feet per Minute; Diameters in Inches								
	πD	$\frac{\pi D}{12}$	20	25	30	35		45			
			40	50	60	70	80	90	100	125	150
In.	In.	Ft.			120	140	160	180	200	250	300
1.000	3.1416	.2618	152.79	190.99	229.18	267.38	305.58	343.77	381.97	477.46	572.96
1.010	3.1730	.2644	151.28	189.10	226.91	264.73	302.55	340.37	378.19	472.74	567.28
1.020	3.2044	.2670	149.79	187.24	224.69	262.14	299.59	337.03	374.48	468.10	561.72
1.030	3.2358	.2697	148.34	185.42	222.51	259.59	296.68	333.76	370.85	463.56	556.27
1.040	3.2673	.2723	146.91	183.64	220.37	257.10	293.82	330.55	367.28	459.10	550.92
1.050	3.2987	.2749	145.51	181.89	218.27	254.65	291.03	327.40	363.78	454.73	545.67
1.060	3.3301	.2775	144.14	180.18	216.21	252.25	288.28	324.32	360.35	450.44	540.53
1.070	3.3615	.2801	142.79	178.49	214.19	249.89	285.59	321.28	356.98	446.23	535.47
1.080	3.3929	.2827	141.47	176.84	212.21	247.57	282.94	318.31	353.68	442.10	530.52
1.090	3.4243	.2854	140.17	175.22	210.26	245.30	280.35	315.39	350.43	438.04	525.65
1.100	3.4558	.2880	138.90	173.62	208.35	243.07	277.80	312.52	347.25	434.06	520.87
1.110	3.4872	.2906	137.65	172.06	206.47	240.88	275.30	309.71	344.12	430.15	516.18
1.120	3.5186	.2932	136.42	170.52	204.63	238.73	272.84	306.94	341.05	426.31	511.57
1.130	3.5500	.2958	135.21	169.01	202.82	236.62	270.42	304.23	338.03	422.54	507.04
1.140	3.5814	.2985	134.03	167.53	201.04	234.54	268.05	301.56	335.06	418.83	502.59
1.150	3.6128	.3011	132.86	166.07	199.29	232.50	265.72	298.93	332.15	415.19	498.22
1.160	3.6442	.3037	131.71	164.64	197.57	230.50	263.43	296.36	329.29	411.61	493.93
1.170	3.6757	.3063	130.59	163.24	195.88	228.53	261.18	293.82	326.47	408.09	489.71
1.180	3.7071	.3089	129.48	161.85	194.22	226.59	258.96	291.33	323.70	404.63	485.56
1.190	3.7385	.3115	128.39	160.49	192.59	224.69	256.79	288.89	320.98	401.23	481.48
1.200	3.7699	.3142	127.32	159.16	190.99	222.82	254.65	286.48	318.31	397.89	477.46
1.210	3.8013	.3168	126.27	157.84	189.41	220.98	252.54	284.11	315.68	394.60	473.52
1.220	3.8327	.3194	125.24	156.55	187.86	219.16	250.47	281.78	313.09	391.36	469.64
1.230	3.8642	.3220	124.22	155.27	186.33	217.38	248.44	279.49	310.55	388.18	465.82
1.240	3.8956	.3246	123.22	154.02	184.83	215.63	246.43	277.24	308.04	385.05	462.06
1.250	3.9270	.3272	122.23	152.79	183.35	213.90	244.46	275.02	305.58	381.97	458.37
******	******	******	******	******	******	******	******	******	******	******	******
1.300	4.0841	.3403	117.53	146.91	176.29	205.68	235.06	264.44	293.82	367.28	440.74
1.350	4.2412	.3534	113.18	141.47	169.77	198.06	226.35	254.65	282.94	353.68	424.41
1.400	4.3982	.3665	109.13	136.42	163.70	190.99	218.27	245.55	272.84	341.05	409.26
1.450	4.5553	.3796	105.37	131.71	158.06	184.40	210.74	237.09	263.43	329.29	395.14
1.500	4.7124	.3927	101.86	127.32	152.79	178.25	203.72	229.18	254.65	318.31	381.97
1.550	4.8695	.4058	98.57	123.22	147.86	172.50	197.15	221.79	246.43	308.04	369.65
1.600	5.0265	.4189	95.49	119.37	143.24	167.11	190.99	214.86	238.73	298.42	358.10
1.650	5.1836	.4320	92.60	115.75	138.90	162.05	185.20	208.35	231.50	289.37	347.25
1.700	5.3407	.4451	89.88	112.34	134.81	157.28	179.75	202.22	224.69	280.86	337.03
1.750	5.4978	.4581	87.31	109.14	130.96	152.79	174.62	196.44	218.27	272.84	327.40
1.800	5.6549	.4712	84.88	106.10	127.32	148.54	169.77	190.99	212.21	265.26	318.31
1.850	5.8119	.4843	82.59	103.24	123.88	144.53	165.18	185.82	206.47	258.09	309.71
1.900	5.9690	.4974	80.42	100.52	120.62	140.73	160.83	180.93	201.04	251.30	301.56
1.950	6.1261	.5105	78.35	97.94	117.53	137.12	156.71	176.29	195.88	244.85	293.82
2.000	6.2832	.5236	76.39	95.49	114.59	133.69	152.79	171.89	190.99	238.73	286.48
******	******	******	******	******	******	******	******	******	******	******	******
2.100	6.5973	.5498	72.76	90.95	109.13	127.32	145.51	163.70	181.89	227.36	272.84
2.200	6.9115	.5760	69.45	86.81	104.17	121.54	138.90	156.26	173.62	217.03	260.44
2.300	7.2257	.6021	66.43	83.04	99.64	116.25	132.86	149.47	166.07	207.59	249.11
2.400	7.5398	.6283	63.66	79.58	95.49	111.41	127.32	143.24	159.15	198.94	238.73
2.500	7.8540	.6545	61.12	76.39	91.67	106.95	122.23	137.51	152.79	190.99	229.18

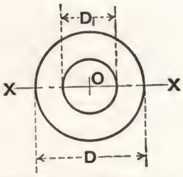
For **surface speeds** (S) in the middle line (40, etc.) use the tabular values.
For **surface speeds** in the upper line (20, etc.) use half the tabular values.
For **surface speeds** in the lower line (120, etc.) use twice the tabular values.
For diameters of 10 D, divide revolutions by 10; for diameters 0.1 D, multiply revolutions by 10.
*****signifies a change in interval in the diameters. Revolutions per minute = (12 S)/(πD), where D is the diameter in inches and S is the surface speed in feet per minute.

REVOLUTIONS PER MINUTE FOR ASSIGNED SURFACE SPEEDS

2.50 to 10.00″
(.250 to 1.000″)
(25.0 to 100.0″)

Diameter D	Circumference		S = Surface Speeds, Feet per Minute; Diameters in Inches								
	πD	$\frac{\pi D}{12}$	20	25	30	35		45			
			40	50	60	70	80	90	100	125	150
In.	In.	Ft.			120	140	160	180	200	250	300
2.500	7.854	.6545	61.12	76.39	91.67	106.95	122.23	137.51	152.79	190.99	229.18
2.600	8.168	.6807	58.76	73.46	88.15	102.84	117.53	132.22	146.91	183.64	220.37
2.700	8.482	.7069	56.59	70.74	84.88	99.03	113.18	127.32	141.47	176.84	212.21
2.800	8.796	.7330	54.57	68.21	81.85	95.49	109.13	122.78	136.42	170.52	204.63
2.900	9.111	.7592	52.69	65.86	79.03	92.20	105.37	118.54	131.71	164.64	197.57
3.000	9.425	.7854	50.93	63.66	76.39	89.13	101.86	114.59	127.32	159.15	190.99
3.100	9.739	.8116	49.29	61.61	73.93	86.25	98.57	110.90	123.22	154.02	184.83
3.200	10.053	.8378	47.75	59.68	71.62	83.56	95.49	107.43	119.37	149.21	179.05
3.300	10.367	.8639	46.30	57.87	69.45	81.02	92.60	104.17	115.75	144.69	173.62
3.400	10.681	.8901	44.94	56.17	67.41	78.64	89.88	101.11	112.34	140.43	168.52
3.500	10.996	.9163	43.65	54.57	65.48	76.39	87.31	98.22	109.13	136.42	163.70
3.600	11.310	.9425	42.44	53.05	63.66	74.27	84.88	95.49	106.10	132.63	159.15
3.700	11.624	.9687	41.29	51.62	61.94	72.26	82.59	92.91	103.24	129.04	154.85
3.800	11.938	.9948	40.21	50.26	60.31	70.36	80.42	90.47	100.52	125.65	150.78
3.900	12.252	1.0210	39.18	48.97	58.76	68.56	78.35	88.15	97.94	122.43	146.91
4.000	12.566	1.0472	38.20	47.75	57.30	66.84	76.39	85.94	95.49	119.37	143.24
******	******	*****	*****	*****	*****	******	******	******	******	*****	******
4.200	13.195	1.0996	36.378	45.473	54.567	63.662	72.757	81.851	90.946	113.68	136.42
4.400	13.823	1.1519	34.725	43.406	52.087	60.768	69.449	78.131	86.812	108.51	130.22
4.600	14.451	1.2043	33.215	41.519	49.822	58.126	66.430	74.734	83.037	103.80	124.56
4.800	15.080	1.2566	31.831	39.789	47.746	55.704	63.662	71.620	79.577	99.47	119.37
5.000	15.708	1.3090	30.558	38.197	45.837	53.476	61.115	68.755	76.394	95.49	114.59
5.200	16.336	1.3614	29.382	36.728	44.074	51.419	58.765	66.111	73.456	91.82	110.18
5.400	16.965	1.4137	28.294	35.368	42.441	49.515	56.588	63.662	70.736	88.41	106.10
5.600	17.593	1.4661	27.284	34.105	40.926	47.746	54.567	61.388	68.209	85.26	102.31
5.800	18.221	1.5184	26.343	32.929	39.514	46.100	52.686	59.271	65.857	82.32	98.79
6.000	18.850	1.5708	25.465	31.831	38.197	44.563	50.930	57.296	63.662	79.58	95.49
6.200	19.478	1.6232	24.643	30.804	36.965	43.126	49.287	55.448	61.608	77.01	92.41
6.400	20.106	1.6755	23.873	29.842	35.810	41.778	47.746	53.715	59.683	74.60	89.52
6.600	20.735	1.7279	23.150	28.937	34.725	40.512	46.300	52.087	57.875	72.34	86.81
6.800	21.363	1.7802	22.469	28.086	33.703	39.321	44.938	50.555	56.172	70.22	84.26
7.000	21.991	1.8326	21.827	27.284	32.740	38.197	43.654	49.111	54.567	68.21	81.85
7.200	22.619	1.8850	21.221	26.526	31.831	37.136	42.441	47.746	53.052	66.31	79.58
7.400	23.248	1.9373	20.647	25.809	30.971	36.132	41.294	46.456	51.618	64.52	77.43
7.600	23.876	1.9897	20.104	25.130	30.156	35.182	40.208	45.234	50.259	62.82	75.39
7.800	24.504	2.0420	19.588	24.485	29.382	34.280	39.177	44.074	48.971	61.21	73.46
8.000	25.133	2.0944	19.099	23.873	28.648	33.423	38.197	42.972	47.746	59.68	71.62
8.200	25.761	2.1468	18.633	23.291	27.950	32.608	37.266	41.924	46.583	58.23	69.87
8.400	26.389	2.1991	18.189	22.736	27.284	31.831	36.378	40.926	45.473	56.84	68.21
8.600	27.018	2.2515	17.766	22.208	26.649	31.091	35.532	39.974	44.415	55.52	66.62
8.800	27.646	2.3038	17.362	21.703	26.043	30.384	34.725	39.065	43.406	54.26	65.11
9.000	28.274	2.3562	16.977	21.221	25.465	29.709	33.953	38.197	42.441	53.05	63.66
9.200	28.903	2.4086	16.607	20.759	24.911	29.063	33.215	37.367	41.519	51.90	62.28
9.400	29.531	2.4609	16.254	20.318	24.381	28.445	32.508	36.572	40.635	50.79	60.95
9.600	30.159	2.5133	15.915	19.894	23.873	27.852	31.831	35.810	39.789	49.74	59.68
9.800	30.788	2.5656	15.591	19.488	23.386	27.284	31.181	35.079	38.977	48.72	58.47
10.000	31.416	2.6180	15.279	19.099	22.918	26.738	30.558	34.377	38.197	47.75	57.30

For **surface speeds** (S) in the middle line (40, etc.) use the tabular values.
For **surface speeds** in the upper line (20, etc.) use half the tabular values.
For **surface speeds** in the lower line (120, etc.) use twice the tabular values.
For diameters of 10 D, divide revolutions by 10; for diameters 0.1 D, multiply revolutions by 10
*****signifies a change in interval in the diameters. Revolutions per minute = (12 S)/(πD) where D is the diameter in inches, and S is the surface speed in feet per minute.



SOLID AND HOLLOW SHAFTING
WITH
WEIGHT AND TORSIONAL STRENGTH REDUCTIONS OF SOLID SHAFT BY HOLE, PER CENT

See Footnotes on pages 372—374.

DIAMETER OF AXIAL HOLE, Inches, D_i. 1st line = % strength reduction from solid, D * 2nd line = % weight reduction from solid, D †

D, In. / $GI_p = \frac{EI_x}{1.30}$ / $S_p = 2S_x$	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	6.25														
1.812(7)	25.00														
1.5708															
3	1.23	19.75													
9.175(7)	11.11	44.44													
5.3015															
4	0.39	6.25	31.64												
2.900(8)	6.25	25.00	56.25												
12.566															
5	0.16	2.56	12.96	40.96											
7.080(8)	4.00	16.00	36.00	64.00											
24.544															
6	0.08	1.23	6.25	19.75	48.23										
1.468(9)	2.78	11.11	25.00	44.44	69.44										
42.412															
7	0.04	0.67	3.37	10.66	26.03	53.98									
2.720(9)	2.04	8.16	18.37	32.65	51.02	73.47									
67.348															
8	0.02	0.39	1.98	6.25	15.26	31.64	58.62								
4.640(9)	1.56	6.25	14.06	25.00	39.06	56.25	76.56								
100.53															
9	0.02	0.24	1.23	3.90	9.53	19.75	36.60	62.43							
7.432(9)	1.23	4.94	11.11	19.75	30.86	44.44	60.49	79.01							
143.14															
10	0.01	0.16	0.81	2.56	6.25	12.96	24.01	40.96	65.61						
11.33 (9)	1.00	4.00	9.00	16.00	25.00	36.00	49.00	64.00	81.00						
196.35															
11				1.75	4.27	8.85	16.40	27.98	44.81	68.30					
16.59 (9)				13.22	20.66	29.75	40.50	52.89	66.94	82.64					
261.34															
12				1.23	3.01	6.25	11.58	19.75	31.64	48.23	70.61				
23.49 (9)				11.11	17.36	25.00	34.03	44.44	56.25	69.44	84.03				
339.29															
13				0.90	2.19	4.54	8.41	14.34	22.97	35.01	51.26	72.60			
32.35 (9)				9.47	14.79	21.30	28.99	37.87	47.93	59.17	71.60	85.21			
431.38															
14				0.67	1.63	3.37	6.25	10.66	17.08	26.03	38.11	53.98	74.35		
43.52 (9)				8.16	12.76	18.37	25.00	32.65	41.33	51.02	61.73	73.47	86.22		
538.78															
15				0.51	1.23	2.56	4.74	8.09	12.96	19.75	28.92	40.96	56.42	75.88	
57.35 (9)				7.11	11.11	16.00	21.78	28.44	36.00	44.44	53.78	64.00	75.11	87.11	
662.68															
16				0.39	0.95	1.98	3.66	6.25	10.01	15.26	22.34	31.64	43.58	58.62	77.25
74.24 (9)				6.25	9.77	14.06	19.14	25.00	31.64	39.06	47.27	56.25	66.02	76.56	87.89
804.25															
17				0.31	0.75	1.55	2.87	4.90	7.86	11.97	17.53	24.83	34.20	46.00	60.61
94.61 (9)				5.54	8.65	12.46	16.96	22.15	28.03	34.60	41.87	49.83	58.48	67.82	77.85
964.67															
18				0.24	0.60	1.23	2.29	3.90	6.25	9.53	13.95	19.75	27.21	36.60	48.23
118.9 (9)				4.94	7.72	11.11	15.12	19.75	25.00	30.86	37.35	44.44	52.16	60.49	69.44
1145.1															

NOTES ON SHAFTING DESIGN AND THE USE OF THE TABLES.

(9) represents 1,000,000,000 times. For example, 1.812(7) = 18,120,000

SOLID SHAFT of DIAMETER, D inches.

STIFFNESS, Inch²-Pounds. TORSIONAL STIFFNESS = (GI_p). BENDING STIFFNESS = (EI_x) = 1.30 (GI_p).

STRENGTH COEFFICIENT (SECTION MODULUS), In.³ Pole O for torsion; axis X-X for bending. Torsional Coefficient = S_p. Bending Coefficient = S_x. $S_p = 2\,S_x$.

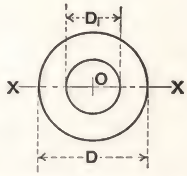
HOLLOW SHAFT (H) of Outside Diameter D and Inside Diameter D_i.

STIFFNESS, $(GI_p)_H = (GI_p)_D - (GI_p)_{Di}$. STRENGTH $(S_p)_H = 2(GI_p)_H/D$. (Not $(S_p)_D - (S_p)_{Di}$.

*Decrease in Strength = $(D_i/D)^4 \times 100\%$. †Decrease in Weight = $(D_i/D)^2 \times 100\%$ Based on solid D.

SOLID AND HOLLOW SHAFTING
WITH
WEIGHT AND TORSIONAL STRENGTH REDUCTIONS OF SOLID SHAFT BY HOLE,
PER CENT

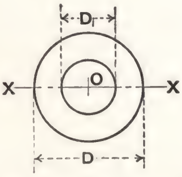
See Footnotes on pages 372-374.



D, In. $GI_p = \frac{EI_x}{1.30}$ $S_p = 2S_x$	DIAMETER OF AXIAL HOLE, Inches, D_i — 1st line = % strength reduction from solid, D. 2d line = % weight reduction from solid, D.										
	4	5	6	7	8	9	10	11	12	13	14	15
19 147.6(9) 1346.8	0.20 4.43	0.48 6.93	0.99 9.97	1.84 13.57	3.14 17.73	5.03 22.44	7.67 27.70	11.23 33.52	15.91 39.89	21.92 46.81	29.48 54.29	38.85 62.33
20 181.2(9) 1570.8	0.16 4.00	0.39 6.25	0.81 9.00	1.50 12.25	2.56 16.00	4.10 20.25	6.25 25.00	9.15 30.25	12.96 36.00	17.85 42.25	24.01 49.00	31.64 56.25
21 220.3(9) 1818.4	0.13 3.63	0.32 5.67	0.67 8.16	1.23 11.11	2.11 14.51	3.37 18.37	5.14 22.68	7.53 27.44	10.66 32.65	14.69 38.32	19.75 44.44	26.03 51.02
22 265.4(9) 2090.7	0.11 3.31	0.27 5.17	0.55 7.44	1.02 10.12	1.75 13.22	2.80 16.74	4.27 20.66	6.25 25.00	8.85 29.75	12.19 34.92	16.40 40.50	21.61 46.49
23 317.0(9) 2389.0	0.09 3.02	0.22 4.73	0.46 6.81	0.86 9.26	1.46 12.10	2.34 15.31	3.57 18.90	5.23 22.87	7.41 27.22	10.21 31.95	13.73 37.05	18.09 42.53
24 375.8(9) 2714.3	0.08 2.78	0.19 4.34	0.39 6.25	0.72 8.51	1.23 11.11	1.98 14.06	3.01 17.36	4.41 21.01	6.25 25.00	8.61 29.34	11.58 34.03	15.26 39.06
25 442.5(9) 3068.0	0.07 2.56	0.16 4.00	0.33 5.76	0.61 7.84	1.05 10.24	1.68 12.96	2.56 16.00	3.75 19.36	5.31 23.04	7.31 27.04	9.83 31.36	12.96 36.00
26 517.7(9) 3451.0	0.06 2.37	0.14 3.70	0.28 5.33	0.53 7.25	0.90 9.47	1.44 11.98	2.19 14.79	3.20 17.90	4.54 21.30	6.25 25.00	8.41 28.99	11.08 33.28
27 602.0(9) 3864.7	0.05 2.19	0.12 3.43	0.24 4.94	0.45 6.72	0.77 8.78	1.23 11.11	1.88 13.72	2.75 16.60	3.90 19.75	5.37 23.18	7.23 26.89	9.53 30.86
28 696.3(9) 4310.3	0.04 2.04	0.10 3.19	0.21 4.59	0.39 6.25	0.67 8.16	1.07 10.33	1.63 12.76	2.38 15.43	3.37 18.37	4.65 21.56	6.25 25.00	8.24 28.70
29 801.2(9) 4788.8	0.04 1.90	0.09 2.97	0.18 4.28	0.34 5.83	0.58 7.61	0.93 9.63	1.41 11.89	2.07 14.39	2.93 17.12	4.04 20.10	5.43 23.31	7.16 26.75
30 917.6(9) 5301.5	0.03 1.78	0.08 2.78	0.16 4.00	0.30 5.44	0.51 7.11	0.81 9.00	1.23 11.11	1.81 13.44	2.56 16.00	3.53 18.78	4.74 21.78	6.25 25.00
31 1046 (9) 5849.5	0.03 1.66	0.07 2.60	0.14 3.75	0.26 5.10	0.44 6.66	0.71 8.43	1.08 10.41	1.59 12.59	2.25 14.98	3.09 17.59	4.16 20.40	5.48 23.41
32 1188 (9) 6434.0	0.02 1.56	0.06 2.44	0.12 3.52	0.23 4.79	0.39 6.25	0.63 7.91	0.95 9.77	1.40 11.82	1.98 14.06	2.72 16.50	3.66 19.14	4.83 21.97
33 1343 (9) 7056.2	0.02 1.47	0.05 2.30	0.11 3.31	0.20 4.50	0.35 5.88	0.55 7.44	0.84 9.18	1.23 11.11	1.75 13.22	2.41 15.52	3.24 18.00	4.27 20.66
34 1514 (9) 7717.3	0.02 1.38	0.05 2.16	0.10 3.11	0.18 4.24	0.31 5.54	0.49 7.01	0.75 8.65	1.10 10.47	1.55 12.46	2.14 14.62	2.87 16.96	3.79 19.46
35 1700 (9) 8418.5	0.02 1.31	0.04 2.04	0.09 2.94	0.16 4.00	0.27 5.22	0.44 6.61	0.67 8.16	0.98 9.88	1.38 11.76	1.90 13.80	2.56 16.00	3.37 18.37

In the tables above, per cent decrease in strength or weight may be found on the line corresponding to the solid shaft diameter and in the column corresponding to the hole diameter.

Tension Modulus of Elasticity = E = 30,000,000 lb. per sq. in. Poisson's Ratio = $(^1/m)$ = .300.
Shearing " " Rigidity = G = ½E/(1 + 1/m) = 30,000,000/2.60 = 11,538,500 lb. per sq. in.
MOMENTS APPLIED at SECTION. In.-Lb. BENDING = M_B. TORSION = M_T.
DISTORTION BETWEEN TWO SECTIONS. TORSION; ϕ = Radians Twist. BENDING; y = Inches Deflection.
DISTORTION AT SECTION. TORSION; $d\phi/dx$ = Radians twist per inch. BENDING; d^2y/dx^2 = Curvature, Inch^{-1}.
$M_T = (GI_p)(d\phi/dx)$; $(d\phi/dx) = M_T/(GI_p)$. $M_B = (EI_x)(d^2y/dx^2)$; $(d^2y/dx^2) = M_B/(EI_x)$.



SOLID AND HOLLOW SHAFTING
WITH
WEIGHT AND TORSIONAL STRENGTH REDUCTIONS OF SOLID SHAFT BY HOLE, PER CENT

See Footnotes on pages 372-374.

D, In. $GI_p = \frac{EI_x}{1.30}$ $S_p = 2S_x$	DIAMETER OF AXIAL HOLE, Inches, D_i.							1st line = % strength reduction from solid, D. 2nd line = % weight reduction from solid, D.						
	16	17	18	19	20	21	22	23	24	25	26	27	28	29
17	78.47													
94.61(9)	88.58													
964.67														
18	62.43	79.56												
118.9(9)	79.01	89.20												
1145.1														
19	50.29	64.09	80.55											
147.6(9)	70.91	80.06	89.75											
1346.8														
20	40.96	52.20	65.61	81.45										
181.2(9)	64.00	72.25	81.00	90.25										
1570.8														
21	33.70	42.95	53.98	67.01	82.27									
220.3(9)	58.04	65.53	73.47	81.86	90.70									
1818.4														
22	27.98	35.65	44.81	55.63	68.30	83.02								
265.4(9)	52.89	59.71	66.94	74.59	82.64	91.16								
2090.7														
23	23.42	29.85	37.51	46.57	57.18	69.50	83.71							
317.0(9)	48.39	54.63	61.25	68.24	75.61	83.36	91.49							
2389.0														
24	19.75	25.17	31.64	39.28	48.23	58.62	70.61	84.35						
375.8(9)	44.44	50.17	56.25	62.67	69.44	76.56	84.03	91.84						
2714.3														
25	16.78	21.38	26.87	33.36	40.96	49.79	59.97	71.64	84.93					
442.5(9)	40.96	46.24	51.84	57.76	64.00	70.56	77.44	84.64	92.16					
3068.0														
26	14.34	18.28	22.97	28.52	35.01	42.56	51.26	61.24	72.60	85.48				
517.7(9)	37.87	42.75	47.93	53.40	59.17	65.24	71.60	78.25	85.21	92.46				
3451.0														
27	12.33	15.72	19.75	24.52	30.11	36.60	44.08	52.66	62.43	73.50	85.99			
602.0(9)	35.12	39.64	44.44	49.52	54.87	60.49	66.39	72.57	79.01	85.73	92.73			
3864.7														
28	10.66	13.59	17.08	21.20	26.03	31.64	38.11	45.53	53.98	63.55	74.35	86.46		
696.3(9)	32.65	36.86	41.33	46.05	51.02	56.25	61.73	67.47	73.47	79.72	86.22	92.98		
4310.3														
29	9.27	11.81	14.84	18.43	22.62	27.50	33.12	39.57	46.91	55.23	64.61	75.14	86.90	
801.2(9)	30.44	34.36	38.53	42.93	47.56	52.44	57.55	62.90	68.49	74.32	80.38	86.68	93.22	
4788.8														
30	8.09	10.31	12.96	16.09	19.75	24.01	28.92	34.55	40.96	48.23	56.42	65.61	75.88	87.32
917.6(9)	28.44	32.11	36.00	40.11	44.44	49.00	53.78	58.78	64.00	69.44	75.11	81.00	87.11	93.44
5301.5														
31	7.10	9.04	11.37	14.11	17.33	21.06	25.37	30.30	35.93	42.30	49.48	57.55	66.56	76.59
1046 (9)	26.64	30.07	33.71	37.57	41.62	45.89	50.36	55.05	59.94	65.04	70.34	75.86	81.58	87.51
5849.5														
32	6.25	7.97	10.01	12.43	15.26	18.55	22.34	26.69	31.64	37.25	43.58	50.68	58.62	67.45
1188 (9)	25.00	28.22	31.64	35.25	39.06	43.07	47.27	51.66	56.25	61.04	66.02	71.19	76.56	82.13
6434.0														
33	5.53	7.04	8.85	10.99	13.49	16.40	19.75	23.60	27.98	32.94	38.53	44.81	51.83	59.64
1343 (9)	23.51	26.54	29.75	33.15	36.73	40.50	44.44	48.58	52.89	57.39	62.08	66.94	71.99	77.23
7056.2														
34	4.90	6.25	7.86	9.75	11.97	14.55	17.53	20.94	24.83	29.23	34.20	39.77	46.00	52.93
1514 (9)	22.15	25.00	28.03	31.23	34.60	38.15	41.87	45.76	49.83	54.07	58.48	63.06	67.82	72.75
7717.3														
35	4.37	5.57	7.00	8.68	10.66	12.96	15.61	18.65	22.11	26.03	30.45	35.41	40.96	47.13
1700 (9)	20.90	23.59	26.45	29.47	32.65	36.00	39.51	43.18	47.02	51.02	55.18	59.51	64.00	68.65
8418.5														

STRESSES AT SECTION. Lb. per sq. in. BENDING = f_B. TORSION = f_T.

$M_T = f_T S_p$; $f_T = M_T/S_p$. $M_B = f_B S_x$; $f_B = M_B/S_x$.

COMBINED STRESSES AT SECTION. Lb. per sq. in. SHEAR = f_s. DIRECT (Tension or Compression) = f_t.

$2 f_s = \sqrt{4 f_T^2 + f_B^2}$ $2 f_t = f_B + 2 f_s$.

PHYSICAL CONSTANTS

OF THE

ALLOY FORMING ELEMENTS

Element	Symbol	Atomic Weight	Melting Point °F	Boiling Point °F	Density Grams per c. c. 20°C.	Atomic Volume c. c. per gram-atom	Mean Linear Coefficient of Thermal Expansion per 1°C x 10^6 (20°C.)	Specific Heat calories (15°) per gram per 1° C. at Room Temp.	Thermal Conductivity at 0° C calories per c. c. per sec per 1° C.	Electric Resistivity Microhms per c. c. 20° C.	Crystallization Shrinkage Per Cent.	Young's Modulus Lbs. per sq. in. x 10^6
Aluminum	Al	26.96	1220	3272	2.702	9.98	23.03	.214	.485	2.62	6.7	10
Antimony	Sb	121.77	1167	2516	6.684s	18.22	11.4	.049	.044	39.	1.4	11
Arsenic	As	74.96	1497 a	1139	5.7 M.H	13.2	4.7	.0822 e	----	35. f	----	----
					4.7 Blk.	15.9	----	----	----	----	----	----
					2.0 Y.C.	38.0	----	----	----	----	----	----
Beryllium	Be	9.02	2460	2730	1.8	5.0	----	.427 e	(.79)	18.5	----	----
Bismuth	Bi	209.0	519.8	2640	9.80	21.33	13.3	.0293	.020	115.	—3.3	4.6
Cadmium	Cd	112.41	609.6	1413	8.6	13.1	29.8	.060	.223	7.5	4.7	10.0
Calcium	Ca	40.07	1490	2140	1.55	25.9	25. b	.155	(.32)	4.6	----	----
Carbon	C	12.000	----	7600	----	----	----	----	----	----	----	----
Diamond		----	----	----	3.51	3.42	0.9	.121	----	$5x10^{20}$n	----	----
Graphite		----	6300	----	2.255	5.32	8.0	.169	.0375	1400	----	----
Cerium	Ce	140.25	1184	2550	6.90	20.33	----	.0423 e	(.019)	78.	----	----
Chromium	Cr	52.01	2939	4000	7.1	7.3	8.2	.106	(.560)	2.6 f	----	----
Cobalt	Co	58.97	2696	5200	8.9	6.6	12.3	.1005	(.150)	9.7	----	----
Copper	Cu	63.57	1981	4170	8.92	7.13	16.6	.0921	.927	1.69	4.1	17.8
Gold	Au	197.2	1945	4700	19.3	10.22	14.2	.0311 k	.707	2.4	5.2	11.1
Indium	In	114.8	311	2640	7.3	15.7	33.	.0568 e	(.162)	9.	----	----
Iridium	Ir	193.1	4262	8670	22.4	8.62	6.5	.0323 e	.141	6.	----	71
Iron	Fe	55.84	2795	5430	7.86	7.10	11.7	.107	.148	10.	----	30
Alpha												
Gamma												
Lead	Pb	207.20	621.5	2950	11.34	18.27	29.1	.0306	.084	21.9	3.4	1
Lithium	Li	6.939	367	2190	0.53	13.1	56.	.79 f	.167	9.3	1.5	----
Magnesium	Mg	24.32	1204	2030	1.74	14.0	25.6	.25	.370	4.46	4.2	6.25
Manganese	Mn	54.93	2300	3450	7.2	7.6	23.	.107 f	(.291)	5.	----	----
Mercury	Hg	200.61	—37.97	674.4	13.5465	14.810	182.	.0334 g	.020	----	3.75	----
Molybdenum	Mo	96.0	4750	6700	10.2	9.4	4.	.065 h	.349	4.77	----	----
Nickel	Ni	58.69	2646	5250	8.90	6.59	12.8	.105	.140	6.9	----	30
Osmium	Os	190.8	4900	9570	22.48	8.488	6.1	.031 h	(.162)	9.	----	----
Palladium	Pd	106.7	2831	3990	12.0	8.9	11.8	.0587 k	.161	10.8	----	14
Phosphorus	P	31.024	111.4 Y.	536	1.82 YH	17.1	125. d	.18 m	----	10^{17} r	----	----
			----	----	2.20 R C	14.1	----	.19 t	----	----	----	----
Platinum	Pt	195.23	3190	7770	21.45	9.102	8.9	.0324	.166	10.5	----	23.5
Rhodium	Rh	102.91	3550	4500	12.5	8.2	8.4	.058 e	.214	5.1	----	42
Ruthenium	Ru	101.7	4440	4890	12.2	8.3	9.1	.061 e	(.145)	10.	----	----
Silicon	Si	28.06	2590	4710	2.4	11.7	2.8—7.3	.176	----	85×10^{3}	----	----
Silver	Ag	107.880	1761	3540	10.5	10.3	18.9	.0558	1.00	1.62	5.0	10.3
Sulphur	S	32.065	235.0	----	2.07 R	15.5	64 p	.171	.0005	2×10^{23}	----	----
			246.2	832.3	1.96M	16.4	----	.179	----		----	----
Tantalum	Ta	181.5	5160	7410	16.6	10.93	7.	.036	.130	15.	----	27
Thorium	Th	232.15	3353	5400	11.2	20.7	----	.0276 e	(.081)	18.	----	----
Tin	Sn	118.70	449.3	4100	7.31WT	16.24	20.	.0542	.157	11.4	2.7	5.9
				----	5.75GC	20.64	----	----	----	----	----	----
Titanium	Ti	47.9	3270	5400	4.5	10.7	----	.144 e	(.485)	3.	----	----
Tungsten	W	184.0	6100	10650	19.3	9.53	4.	.034 h	.382	5.48	----	60
Uranium	U	238.17	3360	----	18.7	12.7	----	.028 e	(.0243)	60.	----	----
Vanadium	V	50.96	3110	5400	5.96	8.55	----	.115 e	----	----	----	----
Zinc	Zn	65.38	787.0	1665	7.14	9.16	33.	.0925	.270	6.	6.5	12.4
Zirconium	Zr	91.	3090	5250	6.4	14.2	----	.0662 e	(.0086)	170. f	----	----

a, 36 atmospheres pressure. b, 0° to 21° C. c, —163 to —18° C. d, 0° to 40° C. e, 0° to 100° C. f, 0° C. g,—40° C. h, 20 to 100° C. k, 18° C. m, 9° C. n, 15° C. p, 40° C. r = 11° C. s, 25° C. t,—21 to +7° C.

( ) Thermal Conductivity = 1.455 ÷ Electric Resistivity (for Metals only). Results are approximate to 2 or 3%.

See p. 392 for miscellaneous conversion coefficients.

WEIGHTS AND SPECIFIC GRAVITIES

Substance	Average Weight Lb. per Cu. Ft.	Average Specific Gravity
Acid, acetic 90%	66.3	1.062
" fluoric 58%	75	1.20
" muriatic (hydrochloric) 40%	75	1.20
" nitric 35%	76	1.216
" " 91%	94	1.50
" phosphoric 72%	97.2	1.557
" sulphuric 87%	112	1.80
" " 97%	115	1.839
Air, 0° C and 760 mm.	.08071	(1) .0012929
Alcohol, 100%	49	.79
" Commercial	52	.832
Alum	33	.53
Aluminum, pure, rolled	167.1	2.68
" wire	168	2.69
" wrought	167	2.67
" bronze 10%	480	7.69
" " 5%	516	8.27
" nickel alloy, annealed	170.9	2.74
" nickel alloy, cast	178.1	2.85
" nickel alloy, rolled	172.1	2.76
" pure, annealed	165.9	2.66
" " cast	159.6	2.56
" " molten	136.6	2.19
Ammonia, liquid 29%	56	.897
" gas	.0478	(.5920)
Anthracite 1.3 to 1.84; Pa. 1.3 to 1.7	93.5	1.5 Av.
Anthracite broken, loose	52-57	
" " mod. shaken	56-60	
" "heaped bushel (77-83)		
" " 40 to 43 ft.^{3} per ton		
Antimony, cast	418	6.70
" native	416	6.66
Arsenic	354	5.67
Asbestos (rock)	200	3.20
Ash, American White, dry	38	.61
" Seasoned Timber	40	.62-.65
Ashes, cinders	40-45	
Asphaltum	81	1.1-1.5
Babbitt	454	7.27
Barium	236	3.78
Basalt	184	2.7-3.2
" —Quarried, piled	96	
Bauxite	159	2.55
Beryllium	120	1.92
Birchwood	41	.65
Bismuth	611	9.79
" molten	627	10.04
Bituminous coal, loose heaped bushel (70-78)		
Bituminous coal, broken, loose	47-52	
" " broken, mod. shaken	51-56	
Bituminous coal, solid 1.2 to 1.5	84 Av.	1.35
Bituminous coal, 43-48 ft.^{3} per ton		

Substance	Average Weight Lb. per Cu. Ft.	Average Specific Gravity
Bluestone	130	2.0-2.2
Borax	110	1.7-1.8
Boron	153	2.45
Brass 67% Cu. 33% Zn. cast	519	8.31
" high yellow plates	535	8.57
" Muntz metal	512	8.20
" Naval, rolled	530	8.49
" Sheet	527	8.44
" Wire	533	8.54
Brick, best pressed	150	
" common and hard	125	
" soft inferior	100	
Brickwork @ 125 lb./ft.^{3}; 1 cube yard = 1.688 (2000) tons; 1 (2000) ton = 16.0 ft.^{3}		
" coarse, inferior, soft	100	1.5-1.7
" medium quality	120	1.8-2.0
" pressed brick, fine joints	140	2.2-2.3
Bromine	199	3.19
Bronze 90% Cu. 10% Sn.	541	8.67
" gun	546	8.75
" Tobin	523	8.38
" 7.9 to 14% Sn.	509	7.4-8.9
Cadmium	540	8.65
" molten	499	7.99
Calcite	170	2.72
Calcium	98	1.57
Carbon	134	2.15
Carbon dioxide	.1234	(1.5291)
" monoxide	.0781	(.9673)
Caustic soda	88	1.41
" " , lye 66%	106	1.70
Cedar, white, red, seasoned	22	.32-.38
" American	35	.56
Cement barrel, 15-30 lb. 20 lbs. Av.		
" mortar, Portland, 1 : 2½	135	2.16
" natural, per bbl. net 282 lb.		
" natural, per bag, net, 94 lb.		
" Portland, loose	88-92	
" " packed	108-115	
" " per bag net 94 lbs.		
" " bbl. net 376 lb.		
" " standard propor.	100	
" " set	183	2.7-3.2
Cerium	417	6.68
Chalk	156	2.50
Charcoal, pine	23	.28-.44
" oak	33	.47-.57
" piled	10-14	
Chestnut, seasoned	41	.66
Chromium	428	6.86
Cinders (coal ashes and clinkers)	40	
Cinnabar	550	8.81

The specific gravities of solids and liquids refer to water at 4 degrees Centigrade, those of gases, when in ( ), to air at 0° C. and 760 mm. pressure. Weight of water at 4° C = 62.4283 lb. per cu. ft.

WEIGHTS AND SPECIFIC GRAVITIES

Substance	Average Weight Lb. per Cu. Ft.	Average Specific Gravity
Clay, marl	137	2.19
" dry in lump, loose	63	
" hard, ordinary	150	2.40
" potters, dry, 1.8 to 2.1	119	1.9
" excavated, damp and plastic	110	
" excavated and gravel, dry	100	
" " in water	80	
Coal, see anthracite; bituminous.		
Cobalt	546	8.75
Coke	75	1.0-1.4
" loose, heaped bushel 35-42 lb.		
" " good quality	23-32	
" 1 ton (2000) requires 63 to 87 ft.^{3}		
Columbium	517	8.28
Concrete, cinder, with Portland Cem.	112	
" conglomerate, with Portland Cement	150	
" gravel, with Portland Cem.	150	
" limestone, with Portland Cem.	148	
" sandstone, with Portland Cem.	143	
" trap, with Portland Cement	155	
" loose, unrammed, 5 to 25% lighter, varying with consistency.		
" masonry, stone, sand, cement	144	2.2-2.4
" masonry, cement, slag, etc.	130	1.9-2.3
" masonry, cement, cinder, etc.	100	1.5-1.7
Copper, cast, 8.6 to 8.8	542	8.68
" hammered	557	8.92
" plates and sheets	557	8.92
" pure	549	8.79
" rolled, 8.8 to 9.0	555	8.89
" wire	554	8.87
" wrought	555	8.89
" ore, pyrites	262	4.1-4.3
Cork, dry	15	.24
Corundum, pure, 3.8 to 4		3.9
Cypress wood	29	.46
Dolomite	181	2.90
Duralumin	180	2.88
Earth, common loam, dry, loose	72-80	
" common loam, dry, shaken	82-92	
" common loam, dry, rammed	90-100	
" common loam, slightly moist	70-76	
" common loam, more so, loose	66-68	

Substance	Average Weight Lb. per Cu. Ft.	Average Specific Gravity
Earth, common loam, more so, shaken	75-90	
" common loam, more so, packed	90-100	
" soft flowing mud	104-112	
" common loam, ditto pressed	110-120	
Ebonite	72	1.15
Elm wood, dry	35	.56
" " seasoned, white	45	.72
Emery	250	4.00
Erbium	310	4.97
Feldspar, orthoclase	159	2.5-2.6
Fir, Douglas spruce, seasoned	32	.51
" eastern	25	.40
Flint	162	2.59
Gallium	370	5.93
Gas, illuminating	.028-.036	(.35-.45)
" natural	.038-.039	(.47-.48)
Gasoline motor	44-47	.71-.75
Germanium, molten	335	5.36
German silver	527	8.44
Glass, common window	156	2.40-2.60
" crown or plate	160	2.45-2.72
" crystal	184	2.90-3.00
" flint	230	3.68
Gneiss, serpentine	159	2.4-2.7
" loose, in piles	96	
Gold, cast, pure or 24-karat	1204	19.29
" pure, hammered	1217	19.49
" std. 22-karat, Au 11, Cu 1	1090	17.46
Granite, syenite	175	2.5-3.1
" broken	96	
" dressed	165	
" rubble	154	
" dry	138	
Graphite	131	1.9-2.3
Gravel, sand, dry, loose	90-105	
" " packed	100-120	
" " wet	118-120	
Greenstone, trap 2.8-3.2	187	3.00
" quarried, piled	107	
Gunmetal	544	8.71
Gutta-percha	61	.98
Gypsum, plaster of paris	77	
" rock, no surface water	140-145	
" crushed rock	90-100	
" ground rock	75-80	
" ditto, calcined, loose	55-65	
" ditto, calcined, well shaken	65-75	
" alabaster	159	2.3-2.8
Hemlock wood	25	.40
" " seasoned	29	.42-.52
Hickory wood, dry	53	.85
" " seasoned	49	.74-.84
Hornblende	187	3.0
Hydrogen	.00559	(0.0693)
Ice .917 to .922	57.4	.92
India Rubber	58	.93

The specific gravities of solids and liquids refer to water at 4° C., those of gases, when in ( ), to air at 0° C. and 760 mm. pressure. Weight of water at 4° C = 62.4283 lb. per cu. ft.

WEIGHTS AND SPECIFIC GRAVITIES

Substance	Average Weight Lb. per Cu. Ft.	Average Specific Gravity
Indium	444	7.12
Iodine	309	4.95
Iridium	1400	22.43
Iron, cast 6.9 to 7.4	446	7.15 Av.
" " grey	442	7.08
" " " foundry, cold	450	7.21
" cast grey foundry, molten	433	6.94
" pure	491	7.87
" white cast	477	7.64
" wire	485	7.77
" wrought	480	7.69
" cast, pig	450	7.2
" steel	489.6	7.843
" spiegeleisen	468	7.50
" ferro-silicon	437	7.00
" ore, hematite	325	5.21
" " " in bank	160-180	
" " " loose	130-160	
" " limonite	237	3.80
" " magnetite	315	5.05
" slag	172	2.5-3.0
Lanthanum	384	6.15
Lead, cast	708	11.34
" commercial	709.6	11.37
" sheet	712	11.41
" ore, galena	465	7.45
" molten	664	10.64
Lignite	78	1.1-1.4
" in piles	40-54	
Lignum-vitae wood, dry	41-83	.66-1.33
Lime	53-64	
" quick	95	1.52
" " ground, shaken thoroughly 93¾ lb. struck bushel	75	
" " ground, shaken, 80 lb.	64	
Limestone and marble	165	2.64
" " " piled	95	
" solid	168	2.69
Lithium	36.8	.59
Loam, see earth.		
Locust wood, dry	44	.70
" " seasoned	46	.74
Lye	110	
" soda, 66%	106	1.70
Magnesite	187	3.0
Magnesium	109	1.75
Manganese	461	7.38
" ore, pyrolusite	259	3.7-4.6
Manganin	525	8.41
Maple, hard seasoned	43	.69
" white "	33	.53
" dry	49	.78
Marble (see Limestone).		
Marl	140	
Masonry debris	90	
" of brick; see brick		
" ashlar, granite, syenite, gneiss	165	2.3-3.0
" ashlar, limestone, marble	160	2.3-2.8

Substance	Average Weight Lb. per Cu. Ft.	Average Specific Gravity
Masonry ashlar, sandstone, bluestone	140	2.1-2.4
" rubble, granite, syenite, gneiss	155	2.2-2.8
" rubble, limestone, marble	150	2.2-2.6
" rubble, sandstone, bluestone	130	2.0-2.2
" dry rubble, gran. syen., gneiss	130	1.9-2.3
" dry rubble, limestone, marble	125	1.9-2.1
" dry rubble, sandstone, bluestone	110	1.8-1.9
" concrete; see Concrete.		
Mercury at 32° F.	849	13.60
" at 68° F.	846	13.55
Mica, 2.75 to 3.1	183	2.93
Molybdenum	636	10.19
Monel metal	554	8.87
Mortar, hardened 1.4 to 1.9	103	1.65
Mud, dry, close	80-110	
" river	90	
" wet, moderately pressed	110-130	
" wet, fluid	104-120	
Neodymium	434	6.95
Nickel, cast	516	8.27
" rolled	541	8.67
" silver (52Cu-26Zn 22 Ni)	527	8.44
Niobium	793	12.7
Nitrogen	.0784	(0.9714)
Oakwood, heart of old	73	1.17
" live, dry .88 to 1.02	59	.95
" red, black, dry	32-45	
" white	52	.83
" seasoned, chestnut	54	.86
" seasoned, live	59	.95
" " red, black	41	.65
" " white	46	.74
Oil, animal and vegetable	58	.91-.94
" kerosene 150° to 300° F.	51.7	.83
" cotton seed	60.2	.96
" lard	57.4	.92
" linseed	58.8	.94
" mineral lubricating	57	.91
" Navy sperm	54	.86
" olive	57	.91
" petroleum	55	.88
" signal	53	.85
" turpentine	54	.86
" whale	58	.93
Osmium	1403	22.47
Oxygen	.0892	(1.1056)
Palladium	749	12.0
Paper, calendered	50-70	
" strawboard, newspaper	33-44	

The specific gravities of solids and liquids refer to water at 4° C., those of gases, when in ( ), to air at 0° C. and 760 mm. pressure. Weight of water at 4° C = 62.4283 lb. per cu. ft.

WEIGHTS AND SPECIFIC GRAVITIES

Substance	Average Weight Lb. per Cu. Ft.	Average Specific Gravity
Paraffine	56	.87-.91
Peat, piled	20-26	
" dry	47	.65-.85
Petroleum	54	.87
" refined	50	.79-.82
" benzine	46	.73-.75
" gasoline	42	.66-.69
Phosphate rock, apatite	200	3.20
Phosphorus, red	146	2.34
" white	115	1.84
Pine wood, white	25	.40
" " yellow, North'n	34	.54
" " " South'n	45	.72
" Oregon, seasoned	32	.51
" Red "	30	.48
" White "	26	.41
" Yellow, long-leaf, seasoned	44	.70
" Yellow, short-leaf, seasoned	38	.61
Pitch	69	1.07-1.15
Plaster	53	
" of paris, see gypsum.		
Platinum	1342	21.50
Poplar wood, dry	29	.46
" " white Spanish	33	.53
" " seasoned	30	.48
Porcelain	149	2.39
Porphyry	172	2.76
Potassium	56	.90
Pumice, natural	40	.37-.90
Quartz, flint	165	2.5-2.8
Redwood, dry	30	.48
" seasoned, Calif.	26	.42
Rhodium	787	12.61
Rope	42	
Rosin	68.6	1.10
Rubber, caoutchouc	59	.92-.96
" goods	94	1.0-2.0
Salt, per struck bushel 56 lb.	45	
" granulated, piled	48	
Saltpeter, loose	68	
Samarium	484	7.75
Sand, of pure quartz, dry	90-106	
" " " " water filled	118-129	
" pure quartz, dry, mixed grains	117	
" excavations in water	60	
" with clay, excavations in water	65	
Sandstone, bluestone	147	2.2-2.5
" quarried and piled	82	
" see masonry.		
Selenium		4.3-4.8
Shale, slate	175	2.7-2.9
" " quarried, piled	92	
Silicon, crystalline	151	2.42
Silver	653	10.46

Substance	Average Weight Lb. per Cu. Ft.	Average Specific Gravity
Slags, bank slag	67-72	
" bank screenings	98-117	
" machine slag	96	
" slag sand	49-55	
Slate 2.7 to 2.9, see Shale.		
Soapstone, talc, 2.65 to 2.8	169	2.6-2.8
Soda ash	74	1.19
Sodium	61	.98
Soil	70	
Spelter 6.8 to 7.2	437.5	7.00
Spruce wood	31	.50
" " old	29	.46
Spruce, white, black, seasoned	27	.40-.46
Steam at 212° F.	.03729	(.4620)
Steel	489.6	7.84
Strontium	159	2.55
Sulphur	125	2.00
Sycamore wood, dry	37	.59
Talc, see soapstone.		
Tar, bituminous	75	1.20
Tellurium	390	6.25
Thallium	740	11.85
Thorium	759	12.16
Tin, cast, 7.2 to 7.5	459	7.35
" pure	455	7.29
" ore cassiterite	418	6.4-7.0
Titanium	281	4.5
Trap rock, compact	188	3.0
" " in pile	107	
Tungsten	1224	19.6
Uranium	1667	26.70
Vanadium	343	5.49
Vapor, alcohol	.122	(1.512)
" spirits of turpentine	.378	(4.68)
" water	.047	(0.58)
Walnut wood, black, dry, seasoned	38	.61
Walnut wood, white, seasoned	26	.42
Water, pure, 32° F. and 30 in.	62.417	
" " 62° F. and 30 in.	62.355	
" " 212° F. and 30 in.	59.830	.9584
" sea	64	1.026-to 1.030
" ice	56	.88-.92
White metal (Babbitts)	456	7.30
Woods metal	605	9.69
Zinc, cast	428	6.86
" pure	446	7.14
" rolled	449	7.19
Zirconium	390	6.25

The specific gravities of solids and liquids refer to water at 4° C., those of gases, when in ( ), to air at 0° C. and 760 mm. pressure. Weight of water at 4° C. = 62.4283 lb. per cu. ft.

COEFFICIENTS OF LINEAR EXPANSION

For 1 degree Centigrade.

For 1 degree Fahrenheit, multiply by 5/9.

Material											
	Centigrade	20 to 100	20 to 200	20 to 300	20 to 400	20 to 500	20 to 600	100 to 200	200 to 300	300 to 400	400 to 500	500 to 600
	Fahrenheit	70 to 210	70 to 390	70 to 570	70 to 750	70 to 930	70 to 1110	210 to 390	390 to 570	570 to 750	750 to 930	930 to 1110
Aluminum	Cast	23.8	24.7	25.7	26.7	27.7	28.7	25.5	27.5	29.5	31.5	33.5
Antimony		10.5*										
Arsenic		5.0*										
Bismuth		13.2*										
Brass, Soft (72 Cu, 28 Zn)	Rolled & Ann.	17.8	18.5	19.1	19.8	20.5						
Brass, Soft (66 Cu, 34 Zn)	Rolled & Ann.	19.5	20.0	20.5	21.1	21.6						
Brass, Naval (60 Cu, 1 Sn, 39 Zn)	Rolled	19.8	20.5	21.2	21.8	22.5						
Bronze, Aluminum	Cast	17.6	17.9	19.2								
Bronze, Lead	Cast	19.1	19.2	19.4	19.5	19.6						
Bronze, Manganese	Cast	20.0	20.4	20.8	21.6	22.7						
Bronze, Nickel	Cast	17.3	17.7	18.1	18.4	18.8						
Bronze, Phosphor	Cast	18.1	18.4	18.8	19.1	19.4						
Cadmium		31.6*										
Carbon (Graphite)		7.86*										
Cobalt		12.36*										
Copper	Rolled	16.6	17.1	17.6	18.1	18.6						
Duralumin		23.8	24.7	25.7	26.3	27.2						
Gold		13.8**										
Gun Metal	Cast	18.7	19.1	19.6	20.0	20.4						
Lead		27.09*										
Magnesium		25.8*										
Monel Metal	Rolled	13.9*	14.4*	14.9*	15.5*	16.0*						
" "	"	13.5*	14.1*	14.7*	15.3*	15.9*						
" "	Cast	16.5*	16.6*	16.8*	17.0*	17.2*						
Muntz Metal (60 Cu, 40 Zn)	Rolled	19.5	20.3	21.0	28.0							
Nickel	Rolled	13.1*	13.8*				15.5	13.5	14.8	17.2	16.6	17.1
Nichrome	Rolled	12.4*	13.0*	13.6*	14.1*	14.7*						
Palladium		11.76*										
Platinum		8.99*										
Silicon		7.63*										
Silver		19.21*										
Silver Solders		19.0*	19.2*	19.6*	20.4*	21.3*						
Tantalum		6.5*										
Tin		22.95*										
Tungsten		4.3*	4.4*	4.5*	4.5*	4.6*		4.5	4.6	4.7	4.8	
Zinc		29.76*										

EXPANSION OF WATER

MAXIMUM DENSITY = 1

C°	Volume	C°	Volume	C°	Volume	C°	Volume	C°	Volume	C°	Volume
0	1.000126	10	1.000257	30	1.004234	50	1.011877	70	1.022384	90	1.035829
4	1.000000	20	1.001732	40	1.007627	60	1.016954	80	1.029003	100	1.043116

*Starting at 0°C or 32° F.
**25—100° C or 75—210° F.

Data on coefficient of expansion abstracted from "Symposium on Effects of Temperature on the Properties of Metals," American Society for Testing Materials and American Society of Mechanical Engineers, June 1931—See Mochel, p. 509 on "Thermal Expansion of Metals."

All coefficients of expansion in table have been multiplied by 10^6. For example, the table gives 12.4, but the actual coefficient is $12.4 \times 10^{-6} = .0000124$.

COEFFICIENTS OF LINEAR EXPANSION

For 1 degree Centigrade.

For 1 degree Fahrenheit, multiply by 5/9.

Material — Centigrade	0 to 100	0 to 200	0 to 300	0 to 400	0 to 500	0 to 600	100 to 200	200 to 300	300 to 400	400 to 500	500 to 600	600 to 700
Fahrenheit	32 to 212	32 to 390	32 to 570	32 to 750	32 to 930	32 to 1110	212 to 390	390 to 570	570 to 750	750 to 930	930 to 1110	1110 to 1290
Electrolytic Iron	12.0		13.3			14.7	13.0	14.5	15.3	15.9	16.8	17.4
Armco Iron	12.2	12.8	13.4	13.9	14.5							
Cast Iron:												
1.10 Si, .300 P, 0.70 Mn, 2.75 GC, 3.06 TC	11.1	11.6	12.2	12.7	13.2							
2.00 Si, .255 P, 0.93 Mn, 2.43 GC, 3.12 TC	10.6	11.3	11.9	12.5	13.2							
1.44 Si, .291 P, 0.85 Mn, 2.88 GC, 3.66 TC	10.4	11.1	11.7	12.3	12.9							
Rolled Carbon Steels:												
0.17 C, 0.42 Mn — Rolled	11.8	12.4	13.0	13.6	14.2							
.08-.18 C, under .55 Mn. Rolled	12.8	13.3	13.9	14.4	14.9							
S.A.E. 1025 — Rolled	12.0	12.6	13.2	13.7	14.3							
S.A.E. 1035 — Rolled	12.6	13.1	13.6	14.0	14.5							
O. H. Screw Stock Cold—Drawn	12.2	12.8	13.5	14.2	14.8							
0.41 C, 0.64 Mn — Annealed	11.1		12.7			14.3	12.2	14.3	15.8	15.7	16.0	16.6
0.59 C, 0.92 Mn — Annealed	11.1		12.9			14.6	12.5	14.6	15.4	16.1	16.8	16.6
0.49 C, 1.21 Mn — Annealed	11.3		12.7			14.5	12.2	14.2	16.3	17.7	15.4	16.7
Forged Carbon Steels:												
0.40-0.45 C, 0.40-0.80 Mn, Nor. and Ann.	11.3	12.1	12.9	13.6	14.4							
S.A.E. 1025 — Q. & D.	12.2	12.8	13.4	14.0	14.7							
S.A.E. 1055 — do.	11.1	11.8	12.5	13.2	13.9							
Cast Carbon Steels:												
0.25-0.35 C, 0.40-1.00 Mn. Annealed	11.9	12.6	13.3	14.0	14.7							
Nickel Steels:												
0.33 C, 0.78 Mn, 3.59 Ni. Annealed	10.9		12.1			13.8	11.5	13.6	15.2	15.1	15.7	
0.33 C, 0.78 Mn, 3.59 Ni. Q. & D.	10.9	11.6	12.3	12.9	13.6							
5% Ni. — Rolled	11.5	12.0	12.4	12.9	13.4							
35% Ni.	3.7		9.2			13.6	8.4	14.1	16.6	18.4	18.8	19.1
36½% Ni. (Invar)‡	2.9‡				10.9‡							14.6‡
Nickel-Chromium Steels:												
S.A.E. 3145 — Q. & D.	11.8	12.3	12.9	13.4	14.0							
S.A.E. 3440 — Q. & D.	11.5	12.1	12.7	13.3	13.9							
Chromium-Vanadium Steels:												
S.A.E. 6115 — Annealed	11.6		12.7			14.0	12.5	13.7	14.6	15.2	16.0	15.8
S.A.E. 6135 — Annealed	11.6		12.9			14.6	12.6	14.2	16.0	15.9	16.4	16.9
Chromium-Molybdenum Steels:												
S.A.E. 4140 — Annealed	11.1	11.7	12.3	13.0	13.6							
Stainless Steels:												
0.30 C, 13.00 Cr — Annealed	10.0		11.0			12.0	10.6	12.0	12.6	13.5	13.9	13.7
0.13 C, 13.50 Cr — Annealed	10.2	10.5	10.9	11.3	11.7	12.1#						
0.15 C, 18.00 Cr, 8.00 Ni. Rolled	17.3											20.2@
0.07 C, 18.00 Cr, 8.00 Ni.	16.0											19.0¢

@ 20—1000° C, or 70—1830° F.
¢ 600—1000° C, or 1110—1830° F.
0— 800° C, or 32—1470° F.

‡ Invar 2.9—20° to 126° C; 10.9—20° to 506° C; 14.6—20° to 971° C.

Data on coefficient of expansion abstracted from "Symposium on Effects of Temperature on the Properties of Metals," American Society for Testing Materials and American Society of Mechanical Engineers, June 1931—See Mochel, p. 509 on "Thermal Expansion of Metals."

All coefficients of expansion in table have been multiplied by 10^6. For example, the table gives 12.4, but the actual coefficient is 12.4×10^{-6}: = .0000124.

WEIGHTS AND MEASURES

WEIGHTS. United States and British. The grain is the unit. 1 grain = 0.0647989 grams.

AVOIRDUPOIS	Grains	Drams	Ounces	Pounds	Hundred-weight I cwt.	Gross Tons
Net ton = 2,000 lb.	1.	.03657	.002286	.000143	.00000128	.000000064
= .892857	27.34375	1.	.0625	.003906	.00003488	.000001744
gross tons	437.5	16.	1.	.0625	.00055804	.00002790
Pound = 1.215278	7000.	256.	16.	1.	.0089286	.0004464
Troy Lb.	784000.	28672.	1792.	112.	1.	.05
1 stone = .125 cwt.	15680000.	573440.	35840.	2240.	20.	1.

TROY	Grains	Pennyweight	Ounces	Pounds
	1	.041667	.0020833	.0001736
	24	1.	.05	.0041667
	480	20.	1.	.0833333
	5760	240.	12.	1.

175 Troy Ounces = 192 Avoirdupois Ounces.
1 Pound Troy = .822857 Lb. Avoir.

APOTHECARIES'	Grains	Scruples	Drams	Ounces	Pounds
	1	.05	.016667	.0020833	.000173611
	20	1.	.333333	.0416667	.0034722
	60	3.	1.	.125	.0104167
	480	24.	8.	1.	.0833333
	5760	288.	96.	12.	1.

Carat. About 3.2 grains.
Carat, International, 205 milligrams = 3.168 grains.
Carat, sometimes 200 milligrams.
1 ounce = 31.1035 grams.
Apothecaries' pound and ounce as for Troy.

LINEAR MEASURE. United States and British. But, 1 yard U. S. = 1.0000029 yds., British; 1 yard British = 0.9999971 yds., U. S.

COMMON MEASURE STATUTE	Inches	Feet	Yards	Rods	Furlongs	Miles
	1	.08333	.02778	.0050505	.00012626	.00001578
	12	1.	.33333	.0606061	.00151515	.00018939
	36	3.	1.	.1818182	.00454545	.00056818
1 U. S. League	198	16.5	5.5	1.	.025	.003125
= 3 statute miles	7920	660.	220.	40.	1.	.125
= 24 furlongs	63360	5280.	1760.	320.	8.	1.

ROPE AND CABLE MEASURE

1 inch = .111111 span = .013889 fathom = .0001157 cable's length.
1 span = 9 inches = .125 fathom = .00104167 cable's length.
1 fathom = 6 feet = 8 spans = 72 inches = .008333 cable's length.
1 cable's length = 120 fathoms = 720 feet = 960 spans = 8640 inches.

NAUTICAL MEASURE

1 nautical mile, as adopted by the United States Coast and Geodetic Survey, equals the length of 1 minute of arc of a great circle of a sphere whose surface equals that of the earth = 6080.20 feet = 1.1516 statute miles.
1 league = 3 nautical miles = 18240.60 feet.

GUNTER'S CHAIN

1 link = 7.92 inches = .01 chain = .000125 miles.
1 chain = 100 links = 66 feet = 4 rods = .0125 miles.
1 mile = 80 chains = 8000 links.

SQUARE OR LAND MEASURE. United States and British.

COMMON MEASURE STATUTE	Square Inches	Square Feet	Square Yards	Square Rods	Acres	Square Miles
	1	.006944	.0007716			
	144	1.	.1111111			
	1296	9.	1.	.03306	.0002066	
	39204	272.25	30.25	1.	.00625	.00000977
	6272640	43560.	4840.	160.	1.	.0015625
		27878400.	3097600.	102400.	640.	1.

1 rood = 40 square rods. Square of 1 acre = 208.7103 feet square.
1 acre = 4 roods. 1 square chain (Gunter's) = 16 sq. rods = 1/10 acre.
1 sq. rod, sq. pole, or sq. perch = 625 sq. links = 1/160 acre

WEIGHTS AND MEASURES

VOLUME MEASURES

CUBIC OR SOLID MEASURE
United States and British

1 cubic inch = .0005787 cubic foot = .000021433 cubic yard.
1 cubic foot = 1728 cubic inches = .03703704 cubic yard.
1 cubic yard = 27 cubic feet = 46656 cubic inches.
1 cord of wood = 128 cubic feet = Solid 4 x 4 x 8 feet.
1 perch of masonry = 24.75 cubic feet = Solid 16.5 x 1.5 x 1 foot. It is usually taken as 25 cubic feet.
1 British Imperial Gallon (dry or liquid) = 1.03202 U. S. dry gallon = 1.20091 U. S. liquid gallon.

DRY MEASURE
United States only

Pints	Quarts	Gallons	Pecks	Bushels	Cubic Inches
1	.50	.125	.0625	.015625	33.6003125
2	1.	.250	.125	.03125	67.200625
8	4.	1.	.5	.125	268.8025
16	8.	2.	1.	.250	537.605
64	32	8.	4.	1.	2150.42

1 heaped bushel = 1.25 struck bushels, but cone must not be less than 6 inches high.

LIQUID MEASURE
United States only

Gills	Pints	Quarts	Gallons	Barrels	Cubic Inches
1	.25	.125	.03125	.000992	7.21875
4	1.	.5	.125	.003968	28.875
8	2.	1.	.25	.007937	57.75
32	8.	4.	1.	.031746	231.
1008	252.	126.	31.5	1.	7276.5

British Imperial Gallon
= 277.410 cubic inches
= 4545.9631 cm^3.
= 10 pounds avoirdupois of pure water at 62° F and barometer at 30 inches.
1 fluid dram = 60 minims
= .125 fluid ounce
= .0078125 pint.
1 fluid ounce
480 minims (m) =
8 fluid drams
= .0625 pint
= 29.574 cm^3.

METRIC SYSTEM

LENGTH, CAPACITY, WEIGHT, MEASURES

LENGTH	Kilometer	Hectometer	Decameter	Meter	Decimeter	Centimeter	Millimeter
CAPACITY	Kiloliter Stere	Hectoliter Decistere	Decaliter Centistere	Liter Millistere	Deciliter	Centiliter	Milliliter
WEIGHT	Kilogram	Hectogram	Decagram	Gram	Decigram	Centigram	Milligram
	1	10	100	1000	10000	100,000	1000000
		1	10	100	1000	10000	100000
			1	10	100	1000	10000
				1	10	100	1000
				.1	1	10	100
				.01	.1	1	10
				.001	.01	.1	1

1 myriameter = 10 kilometers = 10,000 meters.
1 tonne = 1000 kilograms = 100 myriagrams = 10 quintals.
1 liter = 1 cubic decimeter.
1 gram = Weight of 1 cubic centimeter of distilled water at its maximum density at sea level in the latitude of Paris with the barometer at 760 millimeters of mercury.

SQUARE or SURFACE MEASURE

Square Kilometer	Square Hectometer, Hectare	Square Decameter, Are	Square Meter, Centiare	Square Decimeter	Square Centimeter	Square Millimeter
1	100	10000	1000000			
	1	100	10000	1000000		
	.01	1	100	10000	1000000	
	.0001	.01	1	100	10000	1000000
	.000001	.0001	.01	1	100	10000
		.000001	.0001	.01	1	100
			.000001	.0001	.01	1

1 square myriameter = 100 square kilometers = 100,000,000 square meters.

CUBIC MEASURE

Cubic Decameter	Cubic Meter	Cubic Decimeter	Cubic Centimeter	Cubic Millimeter
1	1000	1000000	1000000000	
.001	1	1000	1000000	1000000000
.000001	.001	1	1000	1000000
.000000001	.000001	.001	1	1000
	.000000001	.000001	.001	1

1 cubic meter = 1 kiloliter = 1 stere.

EQUIVALENTS OF MEASURE

LENGTHS

1 meter (m) = 10 decimeters (dm) = 100 centimeters (cm) = 1000 millimeters (mm).
1 meter (m) = 0.1 decameter (dkm) = 0.01 hectometer (hm) = 0.001 kilometer (km).
1 meter (m) = 39.37 inches, U. S. Standard = 39.370113 inches, British Standard.
1 millimeter (mm) = 1000 microns (μ) = 0.03937 inch = 39.37 mils.

Meters, m.	Inches, In.	Feet, ft.	Yard, yd.	Rods, r.	Chains, ch.	Miles, U. S.		Kilometers, km.
						Statute	Nautical	
1	39.37	3.28083	1.09361	0.19884	0.04971	0.(3)6214	0.(3)5396	0.001
0.02540	1	0.08333	0.02778	0.(2)5051	0.(2)1263	0.(4)1578	0.(4)1371	0.(4)2540
0.30480	12	1	0.33333	0.06061	0.01515	0.(3)1894	0.(3)1645	0.(3)3048
0.91440	36	3	1	0.18182	0.04545	0.(3)5682	0.(3)4934	0.(3)9144
5.02921	198	16.5	5.5	1	0.25	0.(2)3125	0.(2)2714	0.(2)5029
20.1168	792	66	22	4	1	0.01250	0.01085	0.02012
1609.35	63360	5280	1760	320	80	1	0.86839	1.60935
1853.25	72962.4	6080.20	2026.73	368.497	92.1242	1.15155	1	1.85325
1000	39370	3280.83	1093.61	198.838	49.7096	0.62137	0.53959	1

1 international geographical mile = 1/15° at equator = 7422 m = 4.611808 U. S. statute miles.
1 international nautical mile = 1/60° at meridian = 1852 m = 0.999326 U. S. nautical miles.
1 U. S. nautical mile = 6080.20 feet = 1.15155 statute miles = 1853.25 meters.
1 British nautical mile = 6080.00 feet = .15152 statute miles = 1853.19 meters.

SURFACES AND AREAS

1 sq. meter (m^2) = 100 sq. decimeters (dm^2) = 10000 sq. centimeters (cm^2)
1 sq. meter (m^2) = 0.01 are (a) = 0.0001 hectare (ha).
1 sq. millimeter (mm^2) = 0.01 cm^2 = 0.00155 sq. inch = 1973.5 circular mils.
1 are (a) = 1 sq. decameter (dkm) = 0.0247105 acre.

Sq. Meters, m^2.	Sq. Inches, sq. in.	Sq. Feet, sq. ft.	Sq. Yards, sq. yd.	Sq. Rods, sq. r.	Acres, A	Hectares, ha.	Sq. Miles, Statute	Sq. Kilometers, km^2.
1	1550.00	10.7639	1.19599	0.03954	0.(3)2471	0.0001	0.(6)3861	0.(5)1
0.(3)6452	1	0.(2)6944	0.(3)7716	0.(4)2551	0.(6)1594	0.(7)6452	0.(9)2491	0.(9)6452
0.09290	144	1	0.11111	0.(2)3673	0.(4)2296	0.(5)9290	0.(7)3587	0.(7)9290
0.83613	1296	9	1	0.03306	0.(3)2066	0.(4)8361	0.(6)3228	0.(6)8361
25.2930	39204	272.25	30.25	1	0.00625	0.(2)2529	0.(5)9766	0.(4)2529
4046.86	6272640	43560	4840	160	1	0.40469	0.(2)1563	0.(2)4047
10000	15499969	107639	11959.9	395.367	2.47105	1	0.(2)3861	0.01
2589999	....	27878400	3097600	102400	640	259.000	1	2.59000
1000000	....	10763867	1195985	39536.7	247.105	100	0.38610	1

Notation .(5) = .00000. For example, .(7)232 = .0000000232.

EQUIVALENTS OF MEASURE

VOLUME AND CAPACITY

1 cu. meter (m^3) = 1000 cu. decimeters (dm^3) = 1000000 cu. centimeters (cm^3).
1 liter (l) = 10 deciliters (dl) = 100 centiliters (cl) = 1000 milliliters (ml) = 1000 cu. centimeters, (cm^3 or c.c.).
1 liter (l) = 0.1 decaliter (dkl) = 0.01 hectoliter (hl) = 1 cu. decimeter (dm^3).

Cubic Deci-meters, dm^3 or Liters, l	Cubic Inches, cu. in.	Cubic Feet, cu. ft.	Cubic Yards, cu. yd.	U. S. Quarts		U. S. Gallons		U. S. Bushels, bu.
				Liquid, l. qt.	Dry, d. qt.	Liquid, l. gal.	Dry, d. gal.	
1	61.0234	0.03531	0.(2)1308	1.05668	0.90808	0.26417	0.22702	0.02838
0.01639	1	0.(3)5787	0.(4)2143	0.01732	0.01488	0.(2)4329	0.(2)3720	0.(3)4650
28.3170	1728	1	0.03704	29.9221	25.7140	7.48052	6.42851	0.80356
764.559	46656	27	1	807.896	694.279	201.974	173.570	21.6962
0.94636	57.75	0.03342	0.(2)1238	1	0.85937	0.25	0.21484	0.02686
1.10123	67.2006	0.03889	0.(2)1440	1.16365	1	0.29091	0.25	0.03125
3.78543	231	0.13368	0.(2)4951	4	3.43747	1	0.85937	0.10742
4.40491	268.803	0.15556	0.(2)5761	4.65459	4	1.16365	1	0.125
35.2393	2150.42	1.24446	0.04609	37.2367	32	9.30920	8	1

1 liter per second = 2.11887 cubic feet per minute = 15.8502 U. S. gallons per minute.
1 U. S. gallon = 0.832702 British Imperial gallons.
Weight of water at maximum density, 4°C, 45° Lat., at sea level, 760 mm barometer:
1 cu. ft. = 62.4283 lbs. av. = 28.3170 kg. 1 cu. in. = 0.57804 oz. av. = 16.3872 g.
1 gal., U. S. liquid = 8.34545 lbs. = 3.78543 kg.
1 gal., British Imperial = 10.0221 lbs. = 4.5459631 kg.

MASSES AND WEIGHTS

1 gram (g) = 10 decigrams (dg) = 100 centigrams (cg) = 1000 milligrams (mg).
1 gram (g) = 0.1 decagram (dkg) = 0.01 hectogram (hg) = 0.001 kilogram (kg).
1 kilogram (kg) = 1 liter of water, (4°C, 45° Lat. at sea level) = 15432.35639 grains, U. S. and British Standard.

Kilograms, kg.	Grains, gr.	Ounces		Pounds		Tons		
		Troy, oz. t.	Avoir., oz. av.	Troy, lb. t.	Avoir., lb. av.	Net (Short), 2000 lbs.	Gross, (Long), 2240 lbs.	Metric, 1000 kg.
1	15432.4	32.1507	35.2740	2.67923	2.20462	0.(2)1102	0.(3)9842	0.001
0.(4)6480	1	0.(2)2083	0.(2)2286	0.(3)1736	0.(3)1429	0.(7)7143	0.(7)6378	0.(7)6480
0.03110	480	1	1.09714	0.08333	0.06857	0.(4)3429	0.(4)3061	0.(4)3110
0.02835	437.5	0.91146	1	0.07595	0.06250	0.(4)3125	0.(4)2790	0.(4)2835
0.37324	5760	12	13.1657	1	0.82286	0.(3)4114	0.(3)3673	0.(3)3732
0.45359	7000	14.5833	16	1.21528	1	0.00050	0.(3)4464	0.(3)4536
907.185	14000000	29166.7	32000	2430.56	2000	1	0.89286	0.90719
1016.05	15680000	32666.7	35840	2722.22	2240	1.12	1	1.01605
1000	15432356	32150.7	35274.0	2679.23	2204.62	1.10231	0.98421	1

1 long hundredweight ($l$cwt.) = 1/20 long ton = 4 quarters = 8 stone = 112 lbs. = 50.8024 kg.
Notation .(5) = .00000. For example, .(7)232 = .0000000232.

EQUIVALENTS OF MEASURE

FORCES OR WEIGHTS PER UNITS OF LENGTH (LINEAR WEIGHTS)

1 dyne per centimeter = 0.00101972 g/cm = .000183719 poundal/in.
1 gram per centimeter = 980.665 dynes/cm = 0.180166 poundal/in.
1 poundal per inch = 5443.11 dynes/cm = 5.55043 g/cm = .0310810 pound/in.

Grams per Centi-meter, g/cm	Grains per Inch, gr./in.	Pounds, per Inch, lb./in.	Pounds per Foot, lb./ft.	Pounds per Yard, lb./yd.	Kilograms per Meter, kg/m	Net Tons, (2000 lbs.), per Mile	Gross Tons, (2240 lbs.), per Mile	Metric Tons, (1000 kg), per Kilometer
1	39.1983	0.(2)5600	0.06720	0.20159	0.10	0.17740	0.15839	0.10
0.02551	1	0.(3)1429	0.(2)1714	0.(2)5143	0.(2)2551	0.(2)4526	0.(2)4041	0.(2)2551
178.579	7000	1	12	36	17.8579	31.6800	28.2857	17.8579
14.8816	583.333	0.08333	1	3	1.48816	2.64000	2.35714	1.48816
4.96054	194.444	0.02778	0.33333	1	0.49605	0.88000	0.78571	0.49605
10	391.983	0.05600	0.67197	2.01591	1	1.77400	1.58393	1
5.63697	220.960	0.03157	0.37879	1.13636	0.56370	1	0.89286	0.56370
6.31341	247.475	0.03535	0.42424	1.27273	0.63134	1.12	1	0.63134

FORCES OR WEIGHTS PER UNITS OF AREA (PRESSURE)

1 dyne per sq. centimeter = 0.00101972 g/cm^2 = 0.000466646 poundals/in^2.
1 gram per sq. centimeter = 980.665 dynes/cm^2 = 0.457623 poundals/in^2.
1 poundal per sq. inch = 2142.95 dynes/cm^2 = 2.18520 g/cm^2 = .0310810 pound/in^2.

Kilograms per Sq. Centi-meter, kg/cm^2	Pounds per Sq. Inch, lb./in.^{2}	Pounds per Sq. Foot, lb./ft.^{2}	Net Tons, (2000 lbs.), per Sq. Foot	Atmos-pheres, Standard, 760 mm	Columns of Mercury, (Hg) 13.59593 Sp. G.		Column of Water, Max. Density 4° C	
					Millimeters	Inches	Meters	Feet
1	14.2234	2048.17	1.02408	0.96778	735.514	28.9572	10	32.8083
0.07031	1	144	0.07200	0.06804	51.7116	2.03588	0.70307	2.30665
0.(3)4882	0.(2)6944	1	0.00050	0.(3)4725	0.35911	0.01414	0.(2)4882	0.01602
0.97648	13.8889	2000	1	0.94502	718.216	28.2762	9.76482	32.0367
1.03329	14.6969	2116.35	1.05818	1	760	29.9212	10.3329	33.9005
0.(2)1360	0.01934	2.78468	0.(2)1392	0.(2)1316	1	0.03937	0.01360	0.04461
0.03453	0.49119	70.7310	0.03537	0.03342	25.4001	1	0.34534	1.13299
0.10	1.42234	204.817	0.10241	0.09678	73.5514	2.89572	1	3.28083
0.03048	0.43353	62.4283	0.03121	0.02950	22.4185	0.88262	0.30480	1

FORCES OR WEIGHTS PER UNITS OF VOLUME (DENSITY)

1 dyne per cu. centimeter = 0.00101972 gram/cm^3 = 0.00118528 poundals/in^3.
1 gram per cu. centimeter = 980.665 dynes/cm^3 = 1.162366 poundals/in^3.
1 poundal per cu. inch = 843.680 dynes/cm^3 = 0.860314 g/cm^3 = .0310810 pound/in^3.

Grams per Cu. Centi-meter, g/cm^3	Pounds per Cu. Inch, lb./in.^{3}	Pounds per Cu. Foot, lb./ft.^{3}	Pounds per Cu. Yard, lb./yd.^{3}	Kilograms per Cu. Meter, kg/m^3	Pounds per Bushel, U. S.	Pounds per Gallon, Dry, U. S.	Pounds per Gallon, Liquid, U. S.	Kilograms per Hectoliter kg/hl
1	0.03613	62.4283	1685.56	1000	77.6893	9.71116	8.34545	100
27.6797	1	1728	46656	27679.7	2150.42	268.803	231	2767.97
0.01602	0.(3)5787	1	27	16.0184	1.24446	0.15556	0.13368	1.60184
0.(3)5933	0.(4)2143	0.03704	1	0.59327	0.04609	0.(2)5761	0.(2)4951	0.05933
0.001	0.(4)3613	0.06243	1.68556	1	0.07769	0.(2)9711	0.(2)8345	0.10
0.01287	0.(3)4650	0.80356	21.6962	12.8718	1	0.125	0.10742	1.28718
0.10297	0.(2)3720	6.42851	173.570	102.974	8	1	0.85937	10.2974
0.11983	0.(2)4329	7.48052	201.974	119.826	9.30918	1.16365	1	11.9826
0.01	0.(3)3613	0.62428	16.8557	10	0.77689	0.09711	0.08345	1

The dyne is not affected by g. It will accelerate a free mass of 1 gram 1 cm. per second per second. A poundal is a similar force unaffected by g which will accelerate a pound mass 1 ft. per second per second. 1 poundal = 13,825.525 dynes.

Masses remain unchanged irrespective of location. The gravitational **force,** however, on a standard **mass,** varies with location. The standard acceleration of gravity, g, is 980.665 cm/sec^2 or 32.1740 ft./sec^2, for which the weight of a pound of mass is a force of 1 pound, and the weight of a mass of 1 kilogram is a force of 1 kilogram, thereby defining the lb. and kg. as units of force.

Notation: .(5) = .00000. For example, .(7)232 = .0000000232

EQUIVALENTS OF MEASURE

ENERGY, WORK, HEAT

1 dyne-centimeter = 1 erg = 0.00101972 gram-centimeter = 0.(7)737561 foot-pound.
1 gram-centimeter = 980.665 ergs = 0.(4)723300 foot-pound.
1 foot-pound = 13558208 ergs = 13825.5 gram-centimeters.

Kilogram-meters, kg-m	Foot-Pounds, ft.-lbs.	Horsepower-hour U. S., H. P.-h	Horsepower-hour Metric, 75 kg-m-h	Poncelet-hours, 100 kg-m-h	Kilowatt-hours, kw-h	Joules, 10^7 ergs, J	Thermal Units B. T. U.	Thermal Units Calories, kg-cal
1	7.23300	.(5)365303	.(5)370370	.(5)277778	.(5)272406	9.80665	.(2)929717	.(2)234329
.138255	1	.(6)505051	.(6)512056	.(6)384042	.(6)376616	1.355821	.(2)128538	.(3)323972
273,745	1980000	1	1.013872	.760404	.745700	2684525	2545.06	641.464
270,000	1952910	.986318	1	.750000	.735497	2647796	2510.23	632.687
360,000	2603879	1.315091	1.333333	1	.980665	3530394	3346.98	843.583
367,099	2655223	1.341022	1.359624	1.019718	1	3600000	3412.98	860.217
.1019716	.737561	.(6)372505	.(6)377673	.(6)283255	.(6)277778	1	.(3)948047	.(3)238949
107.5597	777.979	.(3)392919	.(3)398370	.(3)298777	.(3)293000	1054.800	1	.252043
426.7512	3086.69	.(2)155893	.(2)158056	.(2)118542	.(2)116250	4185.000	3.96758	1

POWER, RATE OF ENERGY AND HEAT

1 erg per sec. = 1 dyne-cm/sec. = 0.00101972 gram-cm/sec. = 0.(7)737561 foot-pound/sec.
1 gram-centimeter per second = 980.665 ergs/sec. = 0.(4)723301 foot-pound/sec.
1 foot-pound per second = 13558208 ergs/sec. = 13825.5 gram-cm/sec.

Kilogram-meters per Second, kg-m/sec.	Foot-pounds per Second, ft.-lbs./sec.	Horsepower U. S., 550 ft.-lbs./sec.	Horsepower Metric, 75 kg-m/sec.	Poncelet 100 kg-m/sec.	Kilowatt, kw.	Watts, 10^7 ergs/sec.	Thermal Units per Sec. B. T. U., B.T.U./sec.	Thermal Units per Sec. Calorie, kg-cal/sec.
1	7.23300	.0131509	.0133333	.0100000	.00980665	9.80665	.00929717	.00234329
0.138255	1	.00181818	.00184340	.00138255	.00135582	1.355821	.00128538	.(3)323972
76.0404	550.000	1	1.013872	.760404	.74570	745.70	.706960	.178184
75.0000	542.475	.986318	1	.750000	.735497	735.497	.697287	.175746
100.0000	723.300	1.315091	1.33333	1	.980665	980.665	.929715	.234329
101.9716	737.561	1.341022	1.359624	1.019718	1	1000.000	.948047	.238949
.1019716	.737561	.00134102	.00135962	.00101972	.00100000	1	.(3)948047	.(3)238949
107.5597	777.979	1.414507	1.434129	1.075597	1.0548	1054.80	1	.252043
426.7512	3086.69	5.61217	5.69002	4.26751	4.18500	4185.00	3.96758	1

VELOCITIES AND ACCELERATIONS

1 kine = 1 centimeter per second = 0.0328083 foot per second.
1 radian per second = 57.2958 degrees per sec. = 0.159155 revolutions per sec.
1 gravity = 980.665 centimeters per sec. per sec. = 32.1740 feet per sec. per sec.

Meters per Second, m/sec.	Feet per Second, ft./sec.	Miles per Hour, M/h	Knots per Hour, U. S.	Kilometers per Hour, km/h	Meter per Sec. per Sec. m/sec./sec.	Feet per Sec. per Sec. ft./sec./sec.	Miles per Hour per Sec. M/h/sec.	Kilometers per Hour per Sec. km/h/sec.
1	3.28083	2.23693	1.94253	3.6	-----------	-----------	-----------	-----------
0.30480	1	0.68182	0.59209	1.09728	-----------	-----------	-----------	-----------
0.44704	1.46667	1	0.86839	1.60935	-----------	-----------	-----------	-----------
0.51479	1.68894	1.15155	1	1.85325	-----------	-----------	-----------	-----------
0.27778	0.91134	0.62137	0.53959	1	-----------	-----------	-----------	-----------
-----------	-----------	-----------	-----------	-----------	1	3.28083	2.23693	3.6
-----------	-----------	-----------	-----------	-----------	0.30480	1	0.68182	1.09728
-----------	-----------	-----------	-----------	-----------	0.44704	1.46667	1	1.60935
-----------	-----------	-----------	-----------	-----------	0.27778	0.91134	0.62137	1

NOTES:—

1 Electrical H. P. =746.00 watts. But 1 H.P. of 550 ft.-lbs. per sec. =745.70 watts when g =980.665 cm/sec^2.
1 Watt =1 Joule/sec. =10^7 ergs/sec =10^7 dyne-cm/sec. =3.4130 B.T.U. per hour =.23895 cals$_{15}$° per sec.
1 B.T.U. mean =1054.8 joules =777.98 ft. lbs. =1/180 of heat required to raise 1 lb. water from 32° to 212° F.
Based on International Critical Tables values. 1 Cal.$_{15}$° = 4185 joules = 1000 cal.$_{15}$°.

Notation: .(5) = .00000. . . For example, .(7)232 = .0000000232

TABLES FOR CONVERTING UNITED STATES WEIGHTS AND MEASURES

CUSTOMARY TO METRIC

WEIGHTS

No.	Grains to Milligrams	Troy Ounces to Grams	Avoirdupois Ounces to Grams	Avoirdupois Pounds to Kilograms	Net Tons of 2000 Pounds to Metric Tons	Gross Tons of 2240 Pounds to Metric Tons
1	64.79892	31.10348	28.34953	.45359	.90718	1.01605
2	129.59784	62.20696	56.69905	.90718	1.81437	2.03209
3	194.39675	93.31044	85.04858	1.36078	2.72155	3.04814
4	259.19567	124.41392	113.39811	1.81437	3.62874	4.06419
5	323.99459	155.51740	141.74763	2.26796	4.53592	5.08024
6	388.79351	186.62088	170.09716	2.72155	5.44311	6.09628
7	453.59243	217.72437	198.44669	3.17515	6.35029	7.11233
8	518.39135	248.82785	226.79621	3.62874	7.25748	8.12838
9	583.19026	279.93133	255.14574	4.08233	8.16466	9.14442

1 Avoirdupois Pound = 453.5924277 Grams

LINEAR MEASURE

No.	64ths of an Inch to Millimeters	Inches to Centimeters	Feet to Meters	Yards to Meters	Statute Miles to Kilometers	Nautical Miles to Kilometers
1	.39688	2.54001	.304801	.914402	1.60935	1.85325
2	.79375	5.08001	.609601	1.828804	3.21869	3.70650
3	1.19063	7.62002	.914402	2.743205	4.82804	5.55975
4	1.58750	10.16002	1.219202	3.657607	6.43739	7.41299
5	1.98438	12.70003	1.524003	4.572009	8.04674	9.26624
6	2.38125	15.24003	1.828804	5.486411	9.65608	11.11949
7	2.77813	17.78004	2.133604	6.400813	11.26543	12.97274
8	3.17501	20.32004	2.438405	7.315215	12.87478	14.82599
9	3.57188	22.86005	2.743205	8.229616	14.48412	16.67924

1 Nautical Mile = 1853.25 Meters
1 Gunter's Chain = 20.1168 Meters
1 Fathom = 1.82880 Meters

SQUARE MEASURE

No.	Square Inches to Square Centimeters	Square Feet to Square Meters	Square Yards to Square Meters	Acres to Hectares	Square Miles to Square Kilometers
1	6.45163	.092903	.83613	.40469	2.59000
2	12.90325	.185807	1.67226	.80937	5.18000
3	19.35488	.278710	2.50839	1.21406	7.77000
4	25.80650	.371614	3.34452	1.61875	10.35999
5	32.25813	.464517	4.18065	2.02344	12.94999
6	38.70975	.557420	5.01678	2.42812	15.53999
7	45.16138	.650324	5.85291	2.83281	18.12999
8	51.61301	.743227	6.68905	3.23750	20.71999
9	58.06463	.836131	7.52518	3.64219	23.30999

1 Square Statute Mile = 259.000 Hectares

TABLES FOR CONVERTING UNITED STATES WEIGHTS AND MEASURES

METRIC TO CUSTOMARY

WEIGHTS

No.	Milligrams to Grains	Grams to Troy Ounces	Grams to Avoirdupois Ounces	Kilograms to Avoirdupois Pounds	Tonnes to Net Tons of 2000 Pounds	Tonnes to Gross Tons of 2240 Pounds
1	.015432	.032151	.035274	2.20462	1.10231	.98421
2	.030865	.064301	.070548	4.40924	2.20462	1.96841
3	.046297	.096452	.105822	6.61387	3.30693	2.95262
4	.061729	.128603	.141096	8.81849	4.40924	3.93683
5	.077162	.160754	.176370	11.02311	5.51156	4.92103
6	.092594	.192904	.211644	13.22773	6.61387	5.90524
7	.108026	.225055	.246918	15.43236	7.71618	6.88944
8	.123459	.257206	.282192	17.63698	8.81849	7.87365
9	.138891	.289357	.317466	19.84160	9.92080	8.85786

1 Kilogram = 15432.35639 Grains

LINEAR MEASURE

No.	Millimeters to 64ths of an Inch	Centimeters to Inches	Meters to Feet	Meters to Yards	Kilometers to Statute Miles	Kilometers to Nautical Miles
1	2.51968	.39370	3.280833	1.093611	.62137	.53959
2	5.03936	.78740	6.561667	2.187222	1.24274	1.07919
3	7.55904	1.18110	9.842500	3.280833	1.86411	1.61878
4	10.07872	1.57480	13.123333	4.374444	2.48548	2.15837
5	12.59840	1.96850	16.404167	5.468056	3.10685	2.69796
6	15.11808	2.36220	19.685000	6.561667	3.72822	3.23756
7	17.63776	2.75590	22.965833	7.655278	4.34959	3.77715
8	20.15744	3.14960	26.246667	8.748889	4.97096	4.31674
9	22.67712	3.54330	29.527500	9.842500	5.59233	4.85634

1 Meter = .000539592 Nautical Mile
= .0497097 Gunter's Chain
= .546807 Fathom

SQUARE MEASURE

No.	Square Centimeters to Square Inches	Square Meters to Square Feet	Square Meters to Square Yards	Hectares to Acres	Square Kilometers to Square Miles
1	.15500	10.76387	1.19599	2.47104	.38610
2	.31000	21.52773	2.39197	4.94209	.77220
3	.46500	32.29160	3.58796	7.41313	1.15830
4	.62000	43.05547	4.78394	9.88418	1.54440
5	.77500	53.81934	5.97993	12.35522	1.93050
6	.93000	64.58320	7.17591	14.82626	2.31660
7	1.08500	75.34707	8.37190	17.29731	2.70270
8	1.24000	86.11094	9.56788	19.76835	3.08880
9	1.39500	96.87481	10.76387	22.23940	3.47491

1 Hectare = .00386101 Square Statute Mile

TABLES FOR CONVERTING UNITED STATES WEIGHTS AND MEASURES

CUSTOMARY TO METRIC

CUBIC MEASURE

No.	Cubic Inches to Cubic Centimeters	Cubic Inches to Cubic Decimeters	Cubic Feet to Cubic Meters	Cubic Yards to Cubic Meters
1	16.38716	.016387	.028317	.76456
2	32.77432	.032774	.056634	1.52912
3	49.16149	.049161	.084951	2.29368
4	65.54865	.065549	.113268	3.05824
5	81.93581	.081936	.141585	3.82280
6	98.32297	.098323	.169902	4.58736
7	114.71014	.114710	.198219	5.35192
8	131.09730	.131097	.226536	6.11648
9	147.48446	.147484	.254853	6.88104

CAPACITY MEASURES

No.	Liquid Quarts to Liters	Gallons to Liters	Gallons to Cubic Meters	Bushels to Hectoliters	Fluid Drams to Milliliters or Cubic Centimeters	Fluid Ounces to Milliliters or Cubic Centimeters
1	.94636	3.78543	.0037854	.35239	3.69671	29.57371
2	1.89272	7.57087	.0075709	.70479	7.39343	59.14741
3	2.83908	11.35630	.0113563	1.05718	11.09014	88.72112
4	3.78543	15.14174	.0151417	1.40957	14.78685	118.29483
5	4.73179	18.92717	.0189272	1.76196	18.48357	147.86853
6	5.67815	22.71261	.0227126	2.11436	22.18028	177.44224
7	6.62451	26.49804	.0264980	2.46675	25.87699	207.01595
8	7.57087	30.28348	.0302835	2.81914	29.57371	236.58966
9	8.51723	34.06891	.0340689	3.17154	33.27042	266.16336

MISCELLANEOUS

No.	Pounds per Linear Foot to Kilograms per Linear Meter	Pounds per Square Inch to Kilograms per Square Centimeter	Pounds per Square Foot to Kilograms per Square Meter	Pounds per Cubic Foot to Kilograms per Cubic Meter	Foot-Pounds to Kilogram-Meters	United States Horsepower to Metric Horsepower
1	1.48816	.070307	4.88241	16.01837	.13826	1.01387
2	2.97632	.140613	9.76482	32.03674	.27651	2.02774
3	4.46448	.210920	14.64723	48.05511	.41477	3.04162
4	5.95264	.281227	19.52963	64.07348	.55302	4.05549
5	7.44081	.351533	24.41204	80.09185	.69128	5.06936
6	8.92897	.421840	29.29445	96.11022	.82953	6.08323
7	10.41713	.492147	34.17686	112.12859	.96779	7.09710
8	11.90529	.562453	39.05927	128.14695	1.10604	8.11097
9	13.39345	.632760	43.94168	144.16532	1.24430	9.12485

TABLES FOR CONVERTING UNITED STATES WEIGHTS AND MEASURES

METRIC TO CUSTOMARY

CUBIC MEASURE

No.	Cubic Centimeters to Cubic Inches	Cubic Decimeters to Cubic Inches	Cubic Meters to Cubic Feet	Cubic Meters to Cubic Yards
1	.061023	61.02338	35.31445	1.30794
2	.122047	122.04676	70.62891	2.61589
3	.183070	183.07013	105.94336	3.92383
4	.244094	244.09351	141.25782	5.23177
5	.305117	305.11689	176.57227	6.53971
6	.366140	366.14027	211.88673	7.84766
7	.427164	427.16365	247.20118	9.15560
8	.488187	488.18702	282.51564	10.46354
9	.549210	549.21040	317.83009	11.77148

CAPACITY MEASURES

No.	Liters to Fluid Quarts	Liters to Gallons	Cubic Meters to Gallons	Hectoliters to Bushels	Milliliters or Cubic Centimeters to Fluid Drams	Milliliters or Cubic Centimeters to Fluid Ounces
1	1.05668	.26417	264.17047	2.83774	.27051	.033814
2	2.11336	.52834	528.34093	5.67548	.54102	.067628
3	3.17005	.79251	792.51140	8.51323	.81153	.101441
4	4.22673	1.05668	1056.68187	11.35097	1.08204	.135255
5	5.28341	1.32085	1320.85234	14.18871	1.35255	.169069
6	6.34009	1.58502	1585.02280	17.02645	1.62306	.202883
7	7.39677	1.84919	1849.19327	19.86420	1.89357	.236697
8	8.45345	2.11336	2113.36374	22.70194	2.16408	.270511
9	9.51014	2.37753	2377.53420	25.53968	2.43460	.304324

MISCELLANEOUS

No.	Kilograms per Linear Meter to Pounds per Linear Foot	Kilograms per Square Centimeter to Pounds per Square Inch	Kilograms per Square Meter to Pounds per Square Foot	Kilograms per Cubic Meter to Pounds per Cubic Foot	Kilogram-Meters to Foot-Pounds	Metric Horsepower to United States Horsepower
1	.67197	14.22340	.20482	.062428	7.23300	.98632
2	1.34394	28.44680	.40963	.124857	14.46600	1.97264
3	2.01591	42.67020	.61445	.187285	21.69900	2.95895
4	2.68788	56.89359	.81927	.249713	28.93199	3.94527
5	3.35985	71.11699	1.02408	.312142	36.16499	4.93159
6	4.03182	85.34039	1.22890	.374570	43.39799	5.91791
7	4.70379	99.56379	1.43372	.436998	50.63099	6.90423
8	5.37576	113.78719	1.63854	.499427	57.86399	7.89054
9	6.04773	128.01059	1.84335	.561855	65.09699	8.87686

MISCELLANEOUS DATA

SPECIFIC HEATS AND MELTING POINTS

Substance	Average Specific Heat	Average Watt-Hrs. for 1 Lb. 1° C.	Average Watt-Hrs. for 1 Lb. 1° F.	Heat of Fusion Watt-Hrs. per Lb.	Melting Point Degrees C.	Pounds per Cube Foot
Air (68° F.)	.237	.125	.0695	......	......	0.08074
Aluminum	.22	.116	.065	45.9	660	160.
Brass	.091	.048	.0266	......	850–1200	511–536
Carbon	.204	.107	.0595	......	......	......
Copper	.094	.0495	.0275	22.8	1083	555.
Graphite	.20	.105	.0583	......	......	120—140
Iron, Gray cast	.11	.058	.0322	12.2	1200	450.
	.16	.116	.0645	......	......	......
Lead, solid	.031	.0163	.00905	3.1	327.4	710.
Lead, fluid	.0471	.0248	.0138	......	......	......
Nickel	.11	.058	.0322	2.45	1452	517—573
Paraffin, solid	.62	.326	.181	......	38—56	54.25-56.75
	.69	.363	.202	......	......	......
Paraffin, fluid	.71	.374	.208	18.5	......	52.4—57
Pitch	......	......	......	......	......	67
Rosin, solid	......	......	......	......	......	67
Solder (1 tin, 1 lead)	......	......	......	5.30	205	555.
Solder (2 tin, 1 lead)	......	......	......	9.0	185	520.
Tallow	......	......	......	......	33.3	57—60.5
Tar	......	......	......	......	......	62—63.4
Tin, solid	.056	.0295	.0164	7.4	232	455.
Tin, fluid	.064	.0337	.0187	......	......	436.
Type Metal*	.039	.0206	.0114	......	......	660.
Water (68°)	1.0	.527	.293	42.3	0	62.42
Wax, Bees	......	......	......	22.4	61—68	60—61
Zinc, cast	.093	.049	.0272	14.8	419.4	439—446.5
	.12	.063	.035	......	......	......
Zinc, fluid	......	......	......	......	......	404.

* 80 parts lead, 20 parts antimony.

SPECIFIC ELECTRICAL RESISTANCE
Ordinary Temperatures

Metal	Specific Resistance	Relative Conductance
Aluminum 99.57%	2.828	60.97
Brass	6—9	28.7–19.1
Climax	87	1.98
Cobalt 99.8%	9.7	17.7
Constantan	49	3.52
Copper, annealed	1.7241	100.
Copper, pure	1.692	102.
Ger. Silver (18X)	30—40	5.7—4.3
Iron, 99.98%	10	17.24
Wrought Iron	13.9	12.4
Lead	22	7.8
Manganin	44	3.9
Mercury	95.8	1.8
Molybden.	5.7	30.3
Nickel	7.8	22.1
Nichrome	100	1.724
Platinum	10	17.24
Silver	1.62	106.4
Superior 23	86	2
Tungsten	5.4	31.9

WORK OR HEAT UNITS

1 Kw.-Hr. = 22.761 lb. water heated 62 to 212° F.
= 3.518 lb. water evaporated from and at 212° F. = .2411 lb. carbon oxidized at 62° F.

1 H.p.-Hr. = .17980 lb. carbon oxidized at 62° F. = 2.6233 lb. water evaporated from and at 212° F.
= 16.973 lb. water heated from 62 to 212° F.

1 lb. carbon oxidized at 62° F.
= 14,155 B.t.u. = 1.11 lb. coal oxidized at 62° F. = 2.5 lb. dry wood oxidized.
= 23.6 cube feet of 600 B.t.u. per ft³ illuminating gas oxidized at 62° F. = 4.1474 Kw.-Hr. = 5.5618 H.p.-Hr.
= 11,012,000 ft. lb. = 14.590 lb. water evaporated from and at 212° F. = 94.398 lb. water heated from 62 to 212° F.

1 lb. water evaporated from and at 212° F.
= .28427 Kw.-Hr. = .38121 H.p.-Hr. = 970.2 B.t.u. = 754,800 ft.-lb. = .068540 lb. carbon oxidized at 62° F. = 104,355 kg.-m. = 1,023,400 joules.

Calorie (large or kilogram) = 3.968 B.t.u. B.t.u. = .2520 Calories.
Calories per kilogram = 1.8 B.t.u. per pound. B.t.u. per pound = .5556 Calories per Kilogram.
Calories per liter = 112.366 B.t.u. per cube foot. B.t.u. per cube foot = .0088995 Calories per liter.
Calories per cube meter = .11237 B.t.u. per cube foot. B.t.u. per cube foot = 8.8998 Calories per cube meter.

MISCELLANEOUS CONVERSIONS.

Atomic Volume:—Cube inches per pound atom = 27.680 x c.c. per gram atom.
Thermal Conductivity:—B.t.u. (mean) per hour per degree F. per square foot per foot = 241.86 x cal $_{15°}$ per sec. per 1°C., per cm² per cm.
Electrical Resistivity:—Microhms per sq. in. per ft. = 4.7244 x microhms per cm² per cm.
Ohms per mil foot = 6.0153 x " per cm² per cm.

MILLIMETER EQUIVALENTS TO ONE FOOT

FOR EACH 32ND OF AN INCH

Inch	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″
	0	25.400	50.800	76.200	101.600	127.000	152.400	177.800	203.200	228.600	254.001	279.401
1/32	.7938	26.194	51.594	76.994	102.394	127.794	153.194	178.594	203.994	229.394	254.794	280.194
1/16	1.5875	26.988	52.388	77.788	103.188	128.588	153.988	179.388	204.788	230.188	255.588	280.988
3/32	2.3813	27.781	53.181	78.581	103.981	129.382	154.782	180.182	205.582	230.982	256.382	281.782
1/8	3.1750	28.575	53.975	79.375	104.775	130.175	155.575	180.975	206.375	231.775	257.176	282.576
5/32	3.9688	29.369	54.769	80.169	105.569	130.969	156.369	181.769	207.169	232.569	257.969	283.369
3/16	4.7625	30.163	55.563	80.963	106.363	131.763	157.163	182.563	207.963	233.363	258.763	284.163
7/32	5.5563	30.956	56.356	81.756	107.156	132.557	157.957	183.357	208.757	234.157	259.557	284.957
1/4	6.3500	31.750	57.150	82.550	107.950	133.350	158.750	184.150	209.550	234.950	260.351	285.751
9/32	7.1438	32.544	57.944	83.344	108.744	134.144	159.544	184.944	210.344	235.744	261.144	286.544
5/16	7.9375	33.338	58.738	84.138	109.538	134.938	160.338	185.738	211.138	236.538	261.938	287.338
11/32	8.7313	34.131	59.531	84.931	110.331	135.732	161.132	186.532	211.932	237.332	262.732	288.132
3/8	9.5250	34.925	60.325	85.725	111.125	136.525	161.925	187.325	212.725	238.125	263.526	288.926
13/32	10.3188	35.719	61.119	86.519	111.919	137.319	162.719	188.119	213.519	238.919	264.319	289.719
7/16	11.1125	36.513	61.913	87.313	112.713	138.113	163.513	188.913	214.313	239.713	265.113	290.513
15/32	11.9063	37.306	62.706	88.106	113.506	138.907	164.307	189.707	215.107	240.507	265.907	291.307
1/2	12.7000	38.100	63.500	88.900	114.300	139.700	165.100	190.500	215.900	241.300	266.701	292.101
17/32	13.4938	38.894	64.294	89.694	115.094	140.494	165.894	191.294	216.694	242.094	267.494	292.894
9/16	14.2875	39.688	65.088	90.488	115.888	141.288	166.688	192.088	217.488	242.888	268.288	293.688
19/32	15.0813	40.481	65.881	91.281	116.681	142.082	167.482	192.882	218.282	243.682	269.082	294.482
5/8	15.8750	41.275	66.675	92.075	117.475	142.875	168.275	193.675	219.075	244.475	269.876	295.276
21/32	16.6688	42.069	67.469	92.869	118.269	143.669	169.069	194.469	219.869	245.269	270.669	296.069
11/16	17.4625	42.863	68.263	93.663	119.063	144.463	169.863	195.263	220.663	246.063	271.463	296.863
23/32	18.2563	43.656	69.056	94.456	119.856	145.257	170.657	196.057	221.457	246.857	272.257	297.657
3/4	19.0500	44.450	69.850	95.250	120.650	146.050	171.450	196.850	222.250	247.650	273.051	298.451
25/32	19.8438	45.244	70.644	96.044	121.444	146.844	172.244	197.644	223.044	248.444	273.844	299.244
13/16	20.6375	46.038	71.438	96.838	122.238	147.638	173.038	198.438	223.838	249.238	274.638	300.038
27/32	21.4313	46.831	72.231	97.631	123.032	148.432	173.832	199.232	224.632	250.032	275.432	300.832
7/8	22.2250	47.625	73.025	98.425	123.825	149.225	174.625	200.025	225.425	250.826	276.226	301.626
29/32	23.0188	48.419	73.819	99.219	124.619	150.019	175.419	200.819	226.219	251.619	277.019	302.419
15/16	23.8125	49.213	74.613	100.013	125.413	150.813	176.213	201.613	227.013	252.413	277.813	303.213
31/32	24.6063	50.006	75.406	100.806	126.207	151.607	177.007	202.407	227.807	253.207	278.607	304.007
1	25.4001											

To obtain equivalent in meters, move decimal 3 places to left. $1\frac{1}{8}''$ = 28.575mm = .028575 m.

EQUIVALENTS OF MILLIMETERS IN INCHES

CONVERSION FACTOR: 1 MILLIMETER = .03937 INCH

Milli-meters	0	100	200	300	400	500	600	700	800	900	Milli-meters
0	.000	3.937	7.874	11.811	15.748	19.685	23.622	27.559	31.496	35.433	0
1	.039	3.976	7.913	11.850	15.787	19.724	23.661	27.598	31.535	35.472	1
2	.079	4.016	7.953	11.890	15.827	19.764	23.701	27.638	31.575	35.512	2
3	.118	4.055	7.992	11.929	15.866	19.803	23.740	27.677	31.614	35.551	3
4	.157	4.094	8.031	11.968	15.905	19.842	23.779	27.716	31.653	35.590	4
5	.197	4.134	8.071	12.008	15.945	19.882	23.819	27.756	31.693	35.630	5
6	.236	4.173	8.110	12.047	15.984	19.921	23.858	27.795	31.732	35.669	6
7	.276	4.213	8.150	12.087	16.024	19.961	23.898	27.835	31.772	35.709	7
8	.315	4.252	8.189	12.126	16.063	20.000	23.937	27.874	31.811	35.748	8
9	.354	4.291	8.228	12.165	16.102	20.039	23.976	27.913	31.850	35.787	9
10	.394	4.331	8.268	12.205	16.142	20.079	24.016	27.953	31.890	35.827	10
11	.433	4.370	8.307	12.244	16.181	20.118	24.055	27.992	31.929	35.866	11
12	.472	4.409	8.346	12.283	16.220	20.157	24.094	28.031	31.968	35.905	12
13	.512	4.449	8.386	12.323	16.260	20.197	24.134	28.071	32.008	35.945	13
14	.551	4.488	8.425	12.362	16.299	20.236	24.173	28.110	32.047	35.984	14
15	.591	4.528	8.465	12.402	16.339	20.276	24.213	28.150	32.087	36.024	15
16	.630	4.567	8.504	12.441	16.378	20.315	24.252	28.189	32.126	36.063	16
17	.669	4.606	8.543	12.480	16.417	20.354	24.291	28.228	32.165	36.102	17
18	.709	4.646	8.583	12.520	16.457	20.394	24.331	28.268	32.205	36.142	18
19	.748	4.685	8.622	12.559	16.496	20.433	24.370	28.307	32.244	36.181	19
20	.787	4.724	8.661	12.598	16.535	20.472	24.409	28.346	32.283	36.220	20
21	.827	4.764	8.701	12.638	16.575	20.512	24.449	28.386	32.323	36.260	21
22	.866	4.803	8.740	12.677	16.614	20.551	24.488	28.425	32.362	36.299	22
23	.906	4.843	8.780	12.717	16.654	20.591	24.528	28.465	32.402	36.339	23
24	.945	4.882	8.819	12.756	16.693	20.630	24.567	28.504	32.441	36.378	24
25	.984	4.921	8.858	12.795	16.732	20.669	24.606	28.543	32.480	36.417	25
26	1.024	4.961	8.898	12.835	16.772	20.709	24.646	28.583	32.520	36.457	26
27	1.063	5.000	8.937	12.874	16.811	20.748	24.685	28.622	32.559	36.496	27
28	1.102	5.039	8.976	12.913	16.850	20.787	24.724	28.661	32.598	36.535	28
29	1.142	5.079	9.016	12.953	16.890	20.827	24.764	28.701	32.638	36.575	29
30	1.181	5.118	9.055	12.992	16.929	20.866	24.803	28.740	32.677	36.614	30
31	1.220	5.157	9.094	13.031	16.968	20.905	24.842	28.779	32.716	36.653	31
32	1.260	5.197	9.134	13.071	17.008	20.945	24.882	28.819	32.756	36.693	32
33	1.299	5.236	9.173	13.110	17.047	20.984	24.921	28.858	32.795	36.732	33
34	1.339	5.276	9.213	13.150	17.087	21.024	24.961	28.898	32.835	36.772	34
35	1.378	5.315	9.252	13.189	17.126	21.063	25.000	28.937	32.874	36.811	35
36	1.417	5.354	9.291	13.228	17.165	21.102	25.039	28.976	32.913	36.850	36
37	1.457	5.394	9.331	13.268	17.205	21.142	25.079	29.016	32.953	36.890	37
38	1.496	5.433	9.370	13.307	17.244	21.181	25.118	29.055	32.992	36.929	38
39	1.535	5.472	9.409	13.346	17.283	21.220	25.157	29.094	33.031	36.968	39
40	1.575	5.512	9.449	13.386	17.323	21.260	25.197	29.134	33.071	37.008	40
41	1.614	5.551	9.488	13.425	17.362	21.299	25.236	29.173	33.110	37.047	41
42	1.654	5.591	9.528	13.465	17.402	21.339	25.276	29.213	33.150	37.087	42
43	1.693	5.630	9.567	13.504	17.441	21.378	25.315	29.252	33.189	37.126	43
44	1.732	5.669	9.606	13.543	17.480	21.417	25.354	29.291	33.228	37.165	44
45	1.772	5.709	9.646	13.583	17.520	21.457	25.394	29.331	33.268	37.205	45
46	1.811	5.748	9.685	13.622	17.559	21.496	25.433	29.370	33.307	37.244	46
47	1.850	5.787	9.724	13.661	17.598	21.535	25.472	29.409	33.346	37.283	47
48	1.890	5.827	9.764	13.701	17.638	21.575	25.512	29.449	33.386	37.323	48
49	1.929	5.866	9.803	13.740	17.677	21.614	25.551	29.488	33.425	37.362	49

EQUIVALENTS OF MILLIMETERS IN INCHES

CONVERSION FACTOR: 1 MILLIMETER = .03937 INCH

Milli-meters	0	100	200	300	400	500	600	700	800	900	Milli-meters
50	1.969	5.906	9.843	13.780	17.717	21.654	25.591	29.528	33.465	37.402	50
51	2.008	5.945	9.882	13.819	17.756	21.693	25.630	29.567	33.504	37.441	51
52	2.047	5.984	9.921	13.858	17.795	21.732	25.669	29.606	33.543	37.480	52
53	2.087	6.024	9.961	13.898	17.835	21.772	25.709	29.646	33.583	37.520	53
54	2.126	6.063	10.000	13.937	17.874	21.811	25.748	29.685	33.622	37.559	54
55	2.165	6.102	10.039	13.976	17.913	21.850	25.787	29.724	33.661	37.598	55
56	2.205	6.142	10.079	14.016	17.953	21.890	25.827	29.764	33.701	37.638	56
57	2.244	6.181	10.118	14.055	17.992	21.929	25.866	29.803	33.740	37.677	57
58	2.283	6.220	10.157	14.094	18.031	21.968	25.905	29.842	33.779	37.716	58
59	2.323	6.260	10.197	14.134	18.071	22.008	25.945	29.882	33.819	37.756	59
60	2.362	6.299	10.236	14.173	18.110	22.047	25.984	29.921	33.858	37.795	60
61	2.402	6.339	10.276	14.213	18.150	22.087	26.024	29.961	33.898	37.835	61
62	2.441	6.378	10.315	14.252	18.189	22.126	26.063	30.000	33.937	37.874	62
63	2.480	6.417	10.354	14.291	18.228	22.165	26.102	30.039	33.976	37.913	63
64	2.520	6.457	10.394	14.331	18.268	22.205	26.142	30.079	34.016	37.953	64
65	2.559	6.496	10.433	14.370	18.307	22.244	26.181	30.118	34.055	37.992	65
66	2.598	6.535	10.472	14.409	18.346	22.283	26.220	30.157	34.094	38.031	66
67	2.638	6.575	10.512	14.449	18.386	22.323	26.260	30.197	34.134	38.071	67
68	2.677	6.614	10.551	14.488	18.425	22.362	26.299	30.236	34.173	38.110	68
69	2.717	6.654	10.591	14.528	18.465	22.402	26.339	30.276	34.213	38.150	69
70	2.756	6.693	10.630	14.567	18.504	22.441	26.378	30.315	34.252	38.189	70
71	2.795	6.732	10.669	14.606	18.543	22.480	26.417	30.354	34.291	38.228	71
72	2.835	6.772	10.709	14.646	18.583	22.520	26.457	30.394	34.331	38.268	72
73	2.874	6.811	10.748	14.685	18.622	22.559	26.496	30.433	34.370	38.307	73
74	2.913	6.850	10.787	14.724	18.661	22.598	26.535	30.472	34.409	38.346	74
75	2.953	6.890	10.827	14.764	18.701	22.638	26.575	30.512	34.449	38.386	75
76	2.992	6.929	10.866	14.803	18.740	22.677	26.614	30.551	34.488	38.425	76
77	3.031	6.968	10.905	14.842	18.779	22.716	26.653	30.590	34.527	38.464	77
78	3.071	7.008	10.945	14.882	18.819	22.756	26.693	30.630	34.567	38.504	78
79	3.110	7.047	10.984	14.921	18.858	22.795	26.732	30.669	34.606	38.543	79
80	3.150	7.087	11.024	14.961	18.898	22.835	26.772	30.709	34.646	38.583	80
81	3.189	7.126	11.063	15.000	18.937	22.874	26.811	30.748	34.685	38.622	81
82	3.228	7.165	11.102	15.039	18.976	22.913	26.850	30.787	34.724	38.661	82
83	3.268	7.205	11.142	15.079	19.016	22.953	26.890	30.827	34.764	38.701	83
84	3.307	7.244	11.181	15.118	19.055	22.992	26.929	30.866	34.803	38.740	84
85	3.346	7.283	11.220	15.157	19.094	23.031	26.968	30.905	34.842	38.779	85
86	3.386	7.323	11.260	15.197	19.134	23.071	27.008	30.945	34.882	38.819	86
87	3.425	7.362	11.299	15.236	19.173	23.110	27.047	30.984	34.921	38.858	87
88	3.465	7.402	11.339	15.276	19.213	23.150	27.087	31.024	34.961	38.898	88
89	3.504	7.441	11.378	15.315	19.252	23.189	27.126	31.063	35.000	38.937	89
90	3.543	7.480	11.417	15.354	19.291	23.228	27.165	31.102	35.039	38.976	90
91	3.583	7.520	11.457	15.394	19.331	23.268	27.205	31.142	35.079	39.016	91
92	3.622	7.559	11.496	15.433	19.370	23.307	27.244	31.181	35.118	39.055	92
93	3.661	7.598	11.535	15.472	19.409	23.346	27.283	31.220	35.157	39.094	93
94	3.701	7.638	11.575	15.512	19.449	23.386	27.323	31.260	35.197	39.134	94
95	3.740	7.677	11.614	15.551	19.488	23.425	27.362	31.299	35.236	39.173	95
96	3.780	7.717	11.654	15.591	19.528	23.465	27.402	31.339	35.276	39.213	96
97	3.819	7.756	11.693	15.630	19.567	23.504	27.441	31.378	35.315	39.252	97
98	3.858	7.795	11.732	15.669	19.606	23.543	27.480	31.417	35.354	39.291	98
99	3.898	7.835	11.772	15.709	19.646	23.583	27.520	31.457	35.394	39.331	99

EQUIVALENTS OF METERS IN FEET

Conversion factor: 1 meter = 3.280833333 feet

Meters	0	100	200	300	400	500	600	700	800	900	Meters
0		328.0833	656.1667	984.250	1,312.333	1,640.417	1,968.500	2,296.583	2,624.667	2,952.750	0
1	3.2808	331.3642	659.4475	987.531	1,315.614	1,643.698	1,971.781	2,299.864	2,627.948	2,956.031	1
2	6.5617	334.6450	662.7283	990.812	1,318.895	1,646.978	1,975.062	2,303.145	2,631.228	2,959.312	2
3	9.8425	337.9258	666.0092	994.093	1,322.176	1,650.259	1,978.343	2,306.426	2,634.509	2,962.593	3
4	13.1233	341.2067	669.2900	997.373	1,325.457	1,653.540	1,981.623	2,309.707	2,637.790	2,965.873	4
5	16.4042	344.4875	672.5708	1,000.654	1,328.738	1,656.821	1,984.904	2,312.988	2,641.071	2,969.154	5
6	19.6850	347.7683	675.8517	1,003.935	1,332.018	1,660.102	1,988.185	2,316.268	2,644.352	2,972.435	6
7	22.9658	351.0492	679.1325	1,007.216	1,335.299	1,663.383	1,991.466	2,319.549	2,647.633	2,975.716	7
8	26.2467	354.3300	682.4133	1,010.497	1,338.580	1,666.663	1,994.747	2,322.830	2,650.913	2,978.997	8
9	29.5275	357.6108	685.6942	1,013.778	1,341.861	1,669.944	1,998.028	2,326.111	2,654.194	2,982.278	9
10	32.8083	360.8917	688.9750	1,017.058	1,345.142	1,673.225	2,001.308	2,329.392	2,657.475	2,985.558	10
11	36.0892	364.1725	692.2558	1,020.339	1,348.423	1,676.506	2,004.589	2,332.673	2,660.756	2,988.839	11
12	39.3700	367.4533	695.5367	1,023.620	1,351.703	1,679.787	2,007.870	2,335.953	2,664.037	2,992.120	12
13	42.6508	370.7342	698.8175	1,026.901	1,354.984	1,683.068	2,011.151	2,339.234	2,667,318	2,995.401	13
14	45.9317	374.0150	702.0983	1,030.182	1,358.265	1,686.348	2,014.432	2,342.515	2,670.598	2,998.682	14
15	49.2125	377.2958	705.3792	1,033.463	1,361.546	1,689.629	2,017.713	2,345.796	2,673.879	3,001.963	15
16	52.4933	380.5767	708.6600	1,036.743	1,364.827	1,692.910	2,020.993	2,349.077	2,677.160	3,005.243	16
17	55.7742	383.8575	711.9408	1,040.024	1,368.108	1,696.191	2,024.274	2,352.358	2,680.441	3,008.524	17
18	59.0550	387.1383	715.2217	1,043.305	1,371.388	1,699.472	2,027.555	2,355.638	2,683.722	3,011.805	18
19	62.3358	390.4192	718.5025	1,046.586	1,374.669	1,702.753	2,030.836	2,358.919	2,687.003	3,015.086	19
20	65.6167	393.7000	721.7833	1,049.867	1,377.950	1,706.033	2,034.117	2,362.200	2,690.283	3,018.367	20
21	68.8975	396.9808	725.0642	1,053.148	1,381.231	1,709.314	2,037.398	2,365.481	2,693.564	3,021.648	21
22	72.1783	400.2617	728.3450	1,056.428	1,384.512	1,712.595	2,040.678	2,368.762	2,696.845	3,024.928	22
23	75.4592	403.5425	731.6258	1,059.709	1,387.793	1,715.876	2,043.959	2,372.043	2,700.126	3,028.209	23
24	78.7400	406.8233	734.9067	1,062.990	1,391.073	1,719.157	2,047.240	2,375.323	2,703.407	3,031.490	24
25	82.0208	410.1042	738.1875	1,066.271	1,394.354	1,722.438	2,050.521	2,378.604	2,706.688	3,034.771	25
26	85.3017	413.3850	741.4683	1,069.552	1,397.635	1,725.718	2,053.802	2,381.885	2,709.968	3,038.052	26
27	88.5825	416.6658	744.7492	1,072.833	1,400.916	1,728.999	2,057.083	2,385.166	2,713.249	3,041.333	27
28	91.8633	419.9467	748.0300	1,076.113	1,404.197	1,732.280	2,060.363	2,388.447	2,716.530	3,044.613	28
29	95.1442	423.2275	751.3108	1,079.394	1,407.478	1,735.561	2,063.644	2,391.728	2,719.811	3,047.894	29
30	98.4250	426.5083	754.5917	1,082.675	1,410.758	1,738.842	2,066.925	2,395.008	2,723.092	3,051.175	30
31	101.7058	429.7892	757.8725	1,085.956	1,414.039	1,742.123	2,070.206	2,398.289	2,726.373	3,054.456	31
32	104.9867	433.0700	761.1533	1,089.237	1,417.320	1,745.403	2,073.487	2,401.570	2,729.653	3,057.737	32
33	108.2675	436.3508	764.4342	1,092.518	1,420.601	1,748.684	2,076.768	2,404.851	2,732.934	3,061.018	33
34	111.5483	439.6317	767.7150	1,095.798	1,423.882	1,751.965	2,080.048	2,408.132	2,736.215	3,064.298	34
35	114.8292	442.9125	770.9958	1,099.079	1,427.163	1,755.246	2,083.329	2,411.413	2,739.496	3,067.579	35
36	118.1100	446.1933	774.2767	1,102.360	1,430.443	1,758.527	2,086.610	2,414.693	2,742.777	3,070.860	36
37	121.3908	449.4742	777.5575	1,105.641	1,433.724	1,761.808	2,089.891	2,417.974	2,746.058	3,074.141	37
38	124.6717	452.7550	780.8383	1,108.922	1,437.005	1,765.088	2,093.172	2,421.255	2,749.338	3,077.422	38
39	127.9525	456.0358	784.1192	1,112.203	1,440.286	1,768.369	2,096.453	2,424.536	2,752.619	3,080.703	39
40	131.2333	459.3167	787.4000	1,115.483	1,443.567	1,771.650	2,099.733	2,427.817	2,755.900	3,083.983	40
41	134.5142	462.5975	790.6808	1,118.764	1,446.848	1,774.931	2,103.014	2,431.098	2,759.181	3,087.264	41
42	137.7950	465.8783	793.9617	1,122.045	1,450.128	1,778.212	2,106.295	2,434.378	2,762.462	3,090.545	42
43	141.0758	469.1592	797.2425	1,125.326	1,453.409	1,781.493	2,109.576	2,437.659	2,765.743	3,093.826	43
44	144.3567	472.4400	800.5233	1,128.607	1,456.690	1,784.773	2,112.857	2,440.940	2,769.023	3,097.107	44
45	147.6375	475.7208	803.8042	1,131.888	1,459.971	1,788.054	2,116.138	2,444.221	2,772.304	3,100.388	45
46	150.9183	479.0017	807.0850	1,135.168	1,463.252	1,791.335	2,119.418	2,447.502	2,775.585	3,103.668	46
47	154.1992	482.2825	810.3658	1,138.449	1,466.533	1,794.616	2,122.699	2,450.783	2,778.866	3,106.949	47
48	157.4800	485.5633	813.6467	1,141.730	1,469.813	1,797.897	2,125.980	2,454.063	2,782.147	3,110.230	48
49	160.7608	488.8442	816.9275	1,145.011	1,473.094	1,801.178	2,129.261	2,457.344	2,785.428	3,113.511	49

For feet and inches, use Decimals of a Foot table, p. 458, 459.
For example, 647 meters = 2122.699 ft. = 2122 ft. $8\frac{25}{64}$ in.

EQUIVALENTS OF METERS IN FEET

Conversion factor: 1 meter = 3.280833333 feet

Meters	0	100	200	300	400	500	600	700	800	900	Meters
50	164.0417	492.1250	820.2083	1,148.292	1,476.375	1,804.458	2,132.542	2,460.625	2,788.708	3,116.792	50
51	167.3225	495.4058	823.4892	1,151.573	1,479.656	1,807.739	2,135.823	2,463.906	2,791.989	3,120.073	51
52	170.6033	498.6867	826.7700	1,154.853	1,482.937	1,811.020	2,139.103	2,467.187	2,795.270	3,123.353	52
53	173.8842	501.9675	830.0508	1,158.134	1,486.218	1,814.301	2,142.384	2,470.468	2,798.551	3,126.634	53
54	177.1650	505.2483	833.3317	1,161.415	1,489.498	1,817.582	2,145.665	2,473.748	2,801.832	3,129.915	54
55	180.4458	508.5292	836.6125	1,164.696	1,492.779	1,820.863	2,148.946	2,477.029	2,805.113	3,133.196	55
56	183.7267	511.8100	839.8933	1,167.977	1,496.060	1,824.143	2,152.227	2,480.310	2,808.393	3,136.477	56
57	187.0075	515.0908	843.1742	1,171.258	1,499.341	1,827.424	2,155.508	2,483.591	2,811.674	3,139.758	57
58	190.2883	518.3717	846.4550	1,174.538	1,502.622	1,830.705	2,158.788	2,486.872	2,814.955	3,143.038	58
59	193.5692	521.6525	849.7358	1,177.819	1,505.903	1,833.986	2,162.069	2,490.153	2,818.236	3,146.319	59
60	196.8500	524.9333	853.0167	1,181.100	1,509.183	1,837.267	2,165.350	2,493.433	2,821.517	3,149.600	60
61	200.1308	528.2142	856.2975	1,184.381	1,512.464	1,840.548	2,168.631	2,496.714	2,824.798	3,152.881	61
62	203.4117	531.4950	859.5783	1,187.662	1,515.745	1,843.828	2,171.912	2,499.995	2,828.078	3,156.162	62
63	206.6925	534.7758	862.8592	1,190.943	1,519.026	1,847.109	2,175.193	2,503.276	2,831.359	3,159.443	63
64	209.9733	538.0567	866.1400	1,194.223	1,522.307	1,850.390	2,178.473	2,506.557	2,834.640	3,162.723	64
65	213.2542	541.3375	869.4208	1,197.504	1,525.588	1,853.671	2,181.754	2,509.838	2,837.921	3,166.004	65
66	216.5350	544.6183	872.7017	1,200.785	1,528.868	1,856.952	2,185.035	2,513.118	2,841.202	3,169.285	66
67	219.8158	547.8992	875.9825	1,204.066	1,532.149	1,860.233	2,188.316	2,516.399	2,844.483	3,172.566	67
68	223.0967	551.1800	879.2633	1,207.347	1,535.430	1,863.513	2,191.597	2,519.680	2,847.763	3,175.847	68
69	226.3775	554.4608	882.5442	1,210.628	1,538.711	1,866.794	2,194.878	2,522.961	2,851.044	3,179.128	69
70	229.6583	557.7417	885.8250	1,213.908	1,541.992	1,870.075	2,198.158	2,526.242	2,854.325	3,182.408	70
71	232.9392	561.0225	889.1058	1,217.189	1,545.273	1,873.356	2,201.439	2,529.523	2,857.606	3,185.689	71
72	236.2200	564.3033	892.3867	1,220.470	1,548.553	1,876.637	2,204.720	2,532.803	2,860.887	3,188.970	72
73	239.5008	567.5842	895.6675	1,223.751	1,551.834	1,879.918	2,208.001	2,536.084	2,864.168	3,192.251	73
74	242.7817	570.8650	898.9483	1,227.032	1,555.115	1,883.198	2,211.282	2,539.365	2,867.448	3,195.532	74
75	246.0625	574.1458	902.2292	1,230.313	1,558.396	1,886.479	2,214.563	2,542.646	2,870.729	3,198.813	75
76	249.3433	577.4267	905.5100	1,233.593	1,561.677	1,889.760	2,217.843	2,545.927	2,874.010	3,202.093	76
77	252.6242	580.7075	908.7908	1,236.874	1,564.958	1,893.041	2,221.124	2,549.208	2,877.291	3,205.374	77
78	255.9050	583.9883	912.0717	1,240.155	1,568.238	1,896.322	2,224.405	2,552.488	2,880.572	3,208.655	78
79	259.1858	587.2692	915.3525	1,243.436	1,571.519	1,899.603	2,227.686	2,555.769	2,883.853	3,211.936	79
80	262.4667	590.5500	918.6333	1,246.717	1,574.800	1,902.883	2,230.967	2,559.050	2,887.133	3,215.217	80
81	265.7475	593.8308	921.9142	1,249.998	1,578.081	1,906.164	2,234.248	2,562.331	2,890.414	3,218.498	81
82	269.0283	597.1117	925.1950	1,253.278	1,581.362	1,909.445	2,237.528	2,565.612	2,893.695	3,221.778	82
83	272.3092	600.3925	928.4758	1,256.559	1,584.643	1,912.726	2,240.809	2,568.893	2,896.976	3,225.059	83
84	275.5900	603.6733	931.7567	1,259.840	1,587.923	1,916.007	2,244.090	2,572.173	2,900.257	3,228.340	84
85	278.8708	606.9542	935.0375	1,263.121	1,591.204	1,919.288	2,247.371	2,575.454	2,903.538	3,231.621	85
86	282.1517	610.2350	938.3183	1,266.402	1,594.485	1,922.568	2,250.652	2,578.735	2,906.818	3,234.902	86
87	285.4325	613.5158	941.5992	1,269.683	1,597.766	1,925.849	2,253.933	2,582.016	2,910.099	3,238.183	87
88	288.7133	616.7967	944.8800	1,272.963	1,601.047	1,929.130	2,257.213	2,585.297	2,913.380	3,241.463	88
89	291.9942	620.0775	948.1608	1,276.244	1,604.328	1,932.411	2,260.494	2,588.578	2,916.661	3,244.744	89
90	295.2750	623.3583	951.4417	1,279.525	1,607.608	1,935.692	2,263.775	2,591.858	2,919.942	3,248.025	90
91	298.5558	626.6392	954.7225	1,282.806	1,610.889	1,938.973	2,267.056	2,595.139	2,923.223	3,251.306	91
92	301.8367	629.9200	958.0033	1,286.087	1,614.170	1,942.253	2,270.337	2,598.420	2,926.503	3,254.587	92
93	305.1175	633.2008	961.2842	1,289.368	1,617.451	1,945.534	2,273.618	2,601.701	2,929.784	3,257.868	93
94	308.3983	636.4817	964.5650	1,292.648	1,620.732	1,948.815	2,276.898	2,604.982	2,933.065	3,261.148	94
95	311.6792	639.7625	967.8458	1,295.929	1,624.013	1,952.096	2,280.179	2,608.263	2,936.346	3,264.429	95
96	314.9600	643.0433	971.1267	1,299.210	1,627.293	1,955.377	2,283.460	2,611.543	2,939.627	3,267.710	96
97	318.2408	646.3242	974.4075	1,302.491	1,630.574	1,958.658	2,286.741	2,614.824	2,942.908	3,270.991	97
98	321.5217	649.6050	977.6883	1,305.772	1,633.855	1,961.938	2,290.022	2,618.105	2,946.188	3,274.272	98
99	324.8025	652.8858	980.9692	1,309.053	1,637.136	1,965.219	2,293.303	2,621.386	2,949.469	3,277.553	99

For feet and inches, use Decimals of a Foot table, p. 458, 459.
For example, 381 meters = 1249.998 ft. = 1249 ft. 11 $\frac{31}{32}$ in.

EQUIVALENTS OF FEET IN METERS

Conversion factor: 1 foot = 0.3048006096 meter

Feet	0	100	200	300	400	500	600	700	800	900	Feet
0		30.48006	60.96012	91.4402	121.9202	152.4003	182.8804	213.3604	243.8405	274.3205	0
1	.30480	30.78486	61.26492	91.7450	122.2250	152.7051	183.1852	213.6652	244.1453	274.6253	1
2	.60960	31.08966	61.56972	92.0498	122.5298	153.0099	183.4900	213.9700	244.4501	274.9301	2
3	.91440	31.39446	61.87452	92.3546	122.8346	153.3147	183.7948	214.2748	244.7549	275.2350	3
4	1.21920	31.69926	62.17932	92.6594	123.1394	153.6195	184.0996	214.5796	245.0597	275.5398	4
5	1.52400	32.00406	62.48412	92.9642	123.4442	153.9243	184.4044	214.8844	245.3645	275.8446	5
6	1.82880	32.30886	62.78893	93.2690	123.7490	154.2291	184.7092	215.1892	245.6693	276.1494	6
7	2.13360	32.61367	63.09373	93.5738	124.0538	154.5339	185.0140	215.4940	245.9741	276.4542	7
8	2.43840	32.91847	63.39853	93.8786	124.3586	154.8387	185.3188	215.7988	246.2789	276.7590	8
9	2.74321	33.22327	63.70333	94.1834	124.6634	155.1435	185.6236	216.1036	246.5837	277.0638	9
10	3.04801	33.52807	64.00813	94.4882	124.9682	155.4483	185.9284	216.4084	246.8885	277.3686	10
11	3.35281	33.83287	64.31293	94.7930	125.2731	155.7531	186.2332	216.7132	247.1933	277.6734	11
12	3.65761	34.13767	64.61773	95.0978	125.5779	156.0579	186.5380	217.0180	247.4981	277.9782	12
13	3.96241	34.44247	64.92253	95.4026	125.8827	156.3627	186.8428	217.3228	247.8029	278.2830	13
14	4.26721	34.74727	65.22733	95.7074	126.1875	156.6675	187.1476	217.6276	248.1077	278.5878	14
15	4.57201	35.05207	65.53213	96.0122	126.4923	156.9723	187.4524	217.9324	248.4125	278.8926	15
16	4.87681	35.35687	65.83693	96.3170	126.7971	157.2771	187.7572	218.2372	248.7173	279.1974	16
17	5.18161	35.66167	66.14173	96.6218	127.1019	157.5819	188.0620	218.5420	249.0221	279.5022	17
18	5.48641	35.96647	66.44653	96.9266	127.4067	157.8867	188.3668	218.8468	249.3269	279.8070	18
19	5.79121	36.27127	66.75133	97.2314	127.7115	158.1915	188.6716	219.1516	249.6317	280.1118	19
20	6.09601	36.57607	67.05613	97.5362	128.0163	158.4963	188.9764	219.4564	249.9365	280.4166	20
21	6.40081	36.88087	67.36093	97.8410	128.3211	158.8011	189.2812	219.7612	250.2413	280.7214	21
22	6.70561	37.18567	67.66574	98.1458	128.6259	159.1059	189.5860	220.0660	250.5461	281.0262	22
23	7.01041	37.49047	67.97054	98.4506	128.9307	159.4107	189.8908	220.3708	250.8509	281.3310	23
24	7.31521	37.79528	68.27534	98.7554	129.2355	159.7155	190.1956	220.6756	251.1557	281.6358	24
25	7.62002	38.10008	68.58014	99.0602	129.5403	160.0203	190.5004	220.9804	251.4605	281.9406	25
26	7.92482	38.40488	68.88494	99.3650	129.8451	160.3251	190.8052	221.2852	251.7653	282.2454	26
27	8.22962	38.70968	69.18974	99.6698	130.1499	160.6299	191.1100	221.5900	252.0701	282.5502	27
28	8.53442	39.01448	69.49454	99.9746	130.4547	160.9347	191.4148	221.8948	252.3749	282.8550	28
29	8.83922	39.31928	69.79934	100.2794	130.7595	161.2395	191.7196	222.1996	252.6797	283.1598	29
30	9.14402	39.62408	70.10414	100.5842	131.0643	161.5443	192.0244	222.5044	252.9845	283.4646	30
31	9.44882	39.92888	70.40894	100.8890	131.3691	161.8491	192.3292	222.8092	253.2893	283.7694	31
32	9.75362	40.23368	70.71374	101.1938	131.6739	162.1539	192.6340	223.1140	253.5941	284.0742	32
33	10.05842	40.53848	71.01854	101.4986	131.9787	162.4587	192.9388	223.4188	253.8989	284.3790	33
34	10.36322	40.84328	71.32334	101.8034	132.2835	162.7635	193.2436	223.7236	254.2037	284.6838	34
35	10.66802	41.14808	71.62814	102.1082	132.5883	163.0683	193.5484	224.0284	254.5085	284.9886	35
36	10.97282	41.45288	71.93294	102.4130	132.8931	163.3731	193.8532	224.3332	254.8133	285.2934	36
37	11.27762	41.75768	72.23774	102.7178	133.1979	163.6779	194.1580	224.6380	255.1181	285.5982	37
38	11.58242	42.06248	72.54255	103.0226	133.5027	163.9827	194.4628	224.9428	255.4229	285.9030	38
39	11.88722	42.36728	72.84735	103.3274	133.8075	164.2875	194.7676	225.2477	255.7277	286.2078	39
40	12.19202	42.67209	73.15215	103.6322	134.1123	164.5923	195.0724	225.5525	256.0325	286.5126	40
41	12.49682	42.97689	73.45695	103.9370	134.4171	164.8971	195.3772	225.8573	256.3373	286.8174	41
42	12.80163	43.28169	73.76175	104.2418	134.7219	165.2019	195.6820	226.1621	256.6421	287.1222	42
43	13.10643	43.58649	74.06655	104.5466	135.0267	165.5067	195.9868	226.4669	256.9469	287.4270	43
44	13.41123	43.89129	74.37135	104.8514	135.3315	165.8115	196.2916	226.7717	257.2517	287.7318	44
45	13.71603	44.19609	74.67615	105.1562	135.6363	166.1163	196.5964	227.0765	257.5565	288.0366	45
46	14.02083	44.50089	74.98095	105.4610	135.9411	166.4211	196.9012	227.3813	257.8613	288.3414	46
47	14.32563	44.80569	75.28575	105.7658	136.2459	166.7259	197.2060	227.6861	258.1661	288.6462	47
48	14.63043	45.11049	75.59055	106.0706	136.5507	167.0307	197.5108	227.9909	258.4709	288.9510	48
49	14.93523	45.41529	75.89535	106.3754	136.8555	167.3355	197.8156	228.2957	258.7757	289.2558	49

When feet and inches and fractions are involved, use also Millimeter Equivalents to One Foot table, p. 393. For example, 723 ft. $9\frac{11}{32}$ in. = 220.3708 + .2373 = 220.6081 meters.

EQUIVALENTS OF FEET IN METERS

Conversion factor: 1 foot = 0.3048006096 meter

Feet	0	100	200	300	400	500	600	700	800	900	Feet
50	15.24003	45.72009	76.20015	106.6802	137.1603	167.6403	198.1204	228.6005	259.0805	289.5606	50
51	15.54483	46.02489	76.50495	106.9850	137.4651	167.9451	198.4252	228.9053	259.3853	289.8654	51
52	15.84963	46.32969	76.80975	107.2898	137.7699	168.2499	198.7300	229.2101	259.6901	290.1702	52
53	16.15443	46.63449	77.11455	107.5946	138.0747	168.5547	199.0348	229.5149	259.9949	290.4750	53
54	16.45923	46.93929	77.41935	107.8994	138.3795	168.8595	199.3396	229.8197	260.2997	290.7798	54
55	16.76403	47.24409	77.72416	108.2042	138.6843	169.1643	199.6444	230.1245	260.6045	291.0846	55
56	17.06883	47.54890	78.02896	108.5090	138.9891	169.4691	199.9492	230.4293	260.9093	291.3894	56
57	17.37363	47.85370	78.33376	108.8138	139.2939	169.7739	200.2540	230.7341	261.2141	291.6942	57
58	17.67844	48.15850	78.63856	109.1186	139.5987	170.0787	200.5588	231.0389	261.5189	291.9990	58
59	17.98324	48.46330	78.94336	109.4234	139.9035	170.3835	200.8636	231.3437	261.8237	292.3038	59
60	18.28804	48.76810	79.24816	109.7282	140.2083	170.6883	201.1684	231.6485	262.1285	292.6086	60
61	18.59284	49.07290	79.55296	110.0330	140.5131	170.9931	201.4732	231.9533	262.4333	292.9134	61
62	18.89764	49.37770	79.85776	110.3378	140.8179	171.2979	201.7780	232.2581	262.7381	293.2182	62
63	19.20244	49.68250	80.16256	110.6426	141.1227	171.6027	202.0828	232.5629	263.0429	293.5230	63
64	19.50724	49.98730	80.46736	110.9474	141.4275	171.9075	202.3876	232.8677	263.3477	293.8278	64
65	19.81204	50.29210	80.77216	111.2522	141.7323	172.2123	202.6924	233.1725	263.6525	294.1326	65
66	20.11684	50.59690	81.07696	111.5570	142.0371	172.5171	202.9972	233.4773	263.9573	294.4374	66
67	20.42164	50.90170	81.38176	111.8618	142.3419	172.8219	203.3020	233.7821	264.2621	294.7422	67
68	20.72644	51.20650	81.68656	112.1666	142.6467	173.1267	203.6068	234.0869	264.5669	295.0470	68
69	21.03124	51.51130	81.99136	112.4714	142.9515	173.4315	203.9116	234.3917	264.8717	295.3518	69
70	21.33604	51.81610	82.29616	112.7762	143.2563	173.7363	204.2164	234.6965	265.1765	295.6566	70
71	21.64084	52.12090	82.60097	113.0810	143.5611	174.0411	204.5212	235.0013	265.4813	295.9614	71
72	21.94564	52.42570	82.90577	113.3858	143.8659	174.3459	204.8260	235.3061	265.7861	296.2662	72
73	22.25044	52.73051	83.21057	113.6906	144.1707	174.6507	205.1308	235.6109	266.0909	296.5710	73
74	22.55525	53.03531	83.51537	113.9954	144.4755	174.9555	205.4356	235.9157	266.3957	296.8758	74
75	22.86005	53.34011	83.82017	114.3002	144.7803	175.2604	205.7404	236.2205	266.7005	297.1806	75
76	23.16485	53.64491	84.12497	114.6050	145.0851	175.5652	206.0452	236.5253	267.0053	297.4854	76
77	23.46965	53.94971	84.42977	114.9098	145.3899	175.8700	206.3500	236.8301	267.3101	297.7902	77
78	23.77445	54.25451	84.73457	115.2146	145.6947	176.1748	206.6548	237.1349	267.6149	298.0950	78
79	24.07925	54.55931	85.03937	115.5194	145.9995	176.4796	206.9596	237.4397	267.9197	298.3998	79
80	24.38405	54.86411	85.34417	115.8242	146.3043	176.7844	207.2644	237.7445	268.2245	298.7046	80
81	24.68885	55.16891	85.64897	116.1290	146.6091	177.0892	207.5692	238.0493	268.5293	299.0094	81
82	24.99365	55.47371	85.95377	116.4338	146.9139	177.3940	207.8740	238.3541	268.8341	299.3142	82
83	25.29845	55.77851	86.25857	116.7386	147.2187	177.6988	208.1788	238.6589	269.1389	299.6190	83
84	25.60325	56.08331	86.56337	117.0434	147.5235	178.0036	208.4836	238.9637	269.4437	299.9238	84
85	25.90805	56.38811	86.86817	117.3482	147.8283	178.3084	208.7884	239.2685	269.7485	300.2286	85
86	26.21285	56.69291	87.17297	117.6530	148.1331	178.6132	209.0932	239.5733	270.0533	300.5334	86
87	26.51765	56.99771	87.47777	117.9578	148.4379	178.9180	209.3980	239.8781	270.3581	300.8382	87
88	26.82245	57.30251	87.78258	118.2626	148.7427	179.2228	209.7028	240.1829	270.6629	301.1430	88
89	27.12725	57.60732	88.08738	118.5674	149.0475	179.5276	210.0076	240.4877	270.9677	301.4478	89
90	27.43205	57.91212	88.39218	118.8722	149.3523	179.8324	210.3124	240.7925	271.2725	301.7526	90
91	27.73686	58.21692	88.69698	119.1770	149.6571	180.1372	210.6172	241.0973	271.5773	302.0574	91
92	28.04166	58.52172	89.00178	119.4818	149.9619	180.4420	210.9220	241.4021	271.8821	302.3622	92
93	28.34646	58.82652	89.30658	119.7866	150.2667	180.7468	211.2268	241.7069	272.1869	302.6670	93
94	28.65126	59.13132	89.61138	120.0914	150.5715	181.0516	211.5316	242.0117	272.4917	302.9718	94
95	28.95606	59.43612	89.91618	120.3962	150.8763	181.3564	211.8364	242.3165	272.7965	303.2766	95
96	29.26086	59.74092	90.22098	120.7010	151.1811	181.6612	212.1412	242.6213	273.1013	303.5814	96
97	29.56566	60.04572	90.52578	121.0058	151.4859	181.9660	212.4460	242.9261	273.4061	303.8862	97
98	29.87046	60.35052	90.83058	121.3106	151.7907	182.2708	212.7508	243.2309	273.7109	304.1910	98
99	30.17526	60.65532	91.13538	121.6154	152.0955	182.5756	213.0556	243.5357	274.0157	304.4958	99

When feet and inches and fractions are involved, use also Millimeter Equivalents to One Foot table, p. 393. For example, 479 ft. 7 13/16 in. = 145.9995 + .1984 = 146.1979 meters.

EQUIVALENTS OF KILOGRAMS IN AVOIRDUPOIS POUNDS

Conversion factor: 1 kilogram = 2.204622341 avoirdupois pounds

Kilo-grams	0	100	200	300	400	500	600	700	800	900	Kilo-grams
0		220.4622	440.9245	661.3867	881.8489	1102.311	1322.773	1543.236	1763.698	1984.160	0
1	2.2046	222.6669	443.1291	663.5913	884.0536	1104.516	1324.978	1545.440	1765.902	1986.365	1
2	4.4092	224.8715	445.3337	665.7959	886.2582	1106.720	1327.183	1547.645	1768.107	1988.569	2
3	6.6139	227.0761	447.5383	668.0006	888.4628	1108.925	1329.387	1549.850	1770.312	1990.774	3
4	8.8185	229.2807	449.7430	670.2052	890.6674	1111.130	1331.592	1552.054	1772.516	1992.979	4
5	11.0231	231.4853	451.9476	672.4098	892.8720	1113.334	1333.797	1554.259	1774.721	1995.183	5
6	13.2277	233.6900	454.1522	674.6144	895.0767	1115.539	1336.001	1556.463	1776.926	1997.388	6
7	15.4324	235.8946	456.3568	676.8191	897.2813	1117.744	1338.206	1558.668	1779.130	1999.592	7
8	17.6370	238.0992	458.5614	679.0237	899.4859	1119.948	1340.410	1560.873	1781.335	2001.797	8
9	19.8416	240.3038	460.7661	681.2283	901.6905	1122.153	1342.615	1563.077	1783.539	2004.002	9
10	22.0462	242.5085	462.9707	683.4329	903.8952	1124.357	1344.820	1565.282	1785.744	2006.206	10
11	24.2508	244.7131	465.1753	685.6375	906.0998	1126.562	1347.024	1567.486	1787.949	2008.411	11
12	26.4555	246.9177	467.3799	687.8422	908.3044	1128.767	1349.229	1569.691	1790.153	2010.616	12
13	28.6601	249.1223	469.5846	690.0468	910.5090	1130.971	1351.433	1571.896	1792.358	2012.820	13
14	30.8647	251.3269	471.7892	692.2514	912.7136	1133.176	1353.638	1574.100	1794.563	2015.025	14
15	33.0693	253.5316	473.9938	694.4560	914.9183	1135.381	1355.843	1576.305	1796.767	2017.229	15
16	35.2740	255.7362	476.1984	696.6607	917.1229	1137.585	1358.047	1578.510	1798.972	2019.434	16
17	37.4786	257.9408	478.4030	698.8653	919.3275	1139.790	1360.252	1580.714	1801.176	2021.639	17
18	39.6832	260.1454	480.6077	701.0699	921.5321	1141.994	1362.457	1582.919	1803.381	2023.843	18
19	41.8878	262.3501	482.8123	703.2745	923.7368	1144.199	1364.661	1585.123	1805.586	2026.048	19
20	44.0924	264.5547	485.0169	705.4791	925.9414	1146.404	1366.866	1587.328	1807.790	2028.253	20
21	46.2971	266.7593	487.2215	707.6838	928.1460	1148.608	1369.070	1589.533	1809.995	2030.457	21
22	48.5017	268.9639	489.4262	709.8884	930.3506	1150.813	1371.275	1591.737	1812.200	2032.662	22
23	50.7063	271.1685	491.6308	712.0930	932.5553	1153.017	1373.480	1593.942	1814.404	2034.866	23
24	52.9109	273.3732	493.8354	714.2976	934.7599	1155.222	1375.684	1596.147	1816.609	2037.071	24
25	55.1156	275.5778	496.0400	716.5023	936.9645	1157.427	1377.889	1598.351	1818.813	2039.276	25
26	57.3202	277.7824	498.2446	718.7069	939.1691	1159.631	1380.094	1600.556	1821.018	2041.480	26
27	59.5248	279.9870	500.4493	720.9115	941.3737	1161.836	1382.298	1602.760	1823.223	2043.685	27
28	61.7294	282.1917	502.6539	723.1161	943.5784	1164.041	1384.503	1604.965	1825.427	2045.890	28
29	63.9340	284.3963	504.8585	725.3208	945.7830	1166.245	1386.707	1607.170	1827.632	2048.094	29
30	66.1387	286.6009	507.0631	727.5254	947.9876	1168.450	1388.912	1609.374	1829.837	2050.299	30
31	68.3433	288.8055	509.2678	729.7300	950.1922	1170.654	1391.117	1611.579	1832.041	2052.503	31
32	70.5479	291.0101	511.4724	731.9346	952.3969	1172.859	1393.321	1613.784	1834.246	2054.708	32
33	72.7525	293.2148	513.6770	734.1392	954.6015	1175.064	1395.526	1615.988	1836.450	2056.913	33
34	74.9572	295.4194	515.8816	736.3439	956.8061	1177.268	1397.731	1618.193	1838.655	2059.117	34
35	77.1618	297.6240	518.0863	738.5485	959.0107	1179.473	1399.935	1620.397	1840.860	2061.322	35
36	79.3664	299.8286	520.2909	740.7531	961.2153	1181.678	1402.140	1622.602	1843.064	2063.527	36
37	81.5710	302.0333	522.4955	742.9577	963.4200	1183.882	1404.344	1624.807	1845.269	2065.731	37
38	83.7756	304.2379	524.7001	745.1624	965.6246	1186.087	1406.549	1627.011	1847.474	2067.936	38
39	85.9803	306.4425	526.9047	747.3670	967.8292	1188.291	1408.754	1629.216	1849.678	2070.140	39
40	88.1849	308.6471	529.1094	749.5716	970.0338	1190.496	1410.958	1631.421	1851.883	2072.345	40
41	90.3895	310.8518	531.3140	751.7762	972.2385	1192.701	1413.163	1633.625	1854.087	2074.550	41
42	92.5941	313.0564	533.5186	753.9808	974.4431	1194.905	1415.368	1635.830	1856.292	2076.754	42
43	94.7988	315.2610	535.7232	756.1855	976.6477	1197.110	1417.572	1638.034	1858.497	2078.959	43
44	97.0034	317.4656	537.9279	758.3901	978.8523	1199.315	1419.777	1640.239	1860.701	2081.163	44
45	99.2080	319.6702	540.1325	760.5947	981.0569	1201.519	1421.981	1642.444	1862.906	2083.368	45
46	101.4126	321.8749	542.3371	762.7993	983.2616	1203.724	1424.186	1644.648	1865.111	2085.573	46
47	103.6173	324.0795	544.5417	765.0040	985.4662	1205.928	1426.391	1646.853	1867.315	2087.777	47
48	105.8219	326.2841	546.7463	767.2086	987.6708	1208.133	1428.595	1649.058	1869.520	2089.982	48
49	108.0265	328.4887	548.9510	769.4132	989.8754	1210.338	1430.800	1651.262	1871.724	2092.187	49

EQUIVALENTS OF KILOGRAMS IN AVOIRDUPOIS POUNDS

Kilo-grams	0	100	200	300	400	500	600	700	800	900	Kilo-grams
50	110.2311	330.6934	551.1556	771.6178	992.080	1212.542	1433.005	1653.467	1873.929	2094.391	50
51	112.4357	332.8980	553.3602	773.8224	994.285	1214.747	1435.209	1655.671	1876.134	2096.596	51
52	114.6404	335.1026	555.5648	776.0271	996.489	1216.952	1437.414	1657.876	1878.338	2098.800	52
53	116.8450	337.3072	557.7695	778.2317	998.694	1219.156	1439.618	1660.081	1880.543	2101.005	53
54	119.0496	339.5118	559.9741	780.4363	1000.899	1221.361	1441.823	1662.285	1882.747	2103.210	54
55	121.2542	341.7165	562.1787	782.6409	1003.103	1223.565	1444.028	1664.490	1884.952	2105.414	55
56	123.4589	343.9211	564.3833	784.8456	1005.308	1225.770	1446.232	1666.694	1887.157	2107.619	56
57	125.6635	346.1257	566.5879	787.0502	1007.512	1227.975	1448.437	1668.899	1889.361	2109.824	57
58	127.8681	348.3303	568.7926	789.2548	1009.717	1230.179	1450.642	1671.104	1891.566	2112.028	58
59	130.0727	350.5350	570.9972	791.4594	1011.922	1232.384	1452.846	1673.308	1893.771	2114.233	59
60	132.2773	352.7396	573.2018	793.6640	1014.126	1234.589	1455.051	1675.513	1895.975	2116.437	60
61	134.4820	354.9442	575.4064	795.8687	1016.331	1236.793	1457.255	1677.718	1898.180	2118.642	61
62	136.6866	357.1488	577.6111	798.0733	1018.536	1238.998	1459.460	1679.922	1900.384	2120.847	62
63	138.8912	359.3534	579.8157	800.2779	1020.740	1241.202	1461.665	1682.127	1902.589	2123.051	63
64	141.0958	361.5581	582.0203	802.4825	1022.945	1243.407	1463.869	1684.331	1904.794	2125.256	64
65	143.3005	363.7627	584.2249	804.6872	1025.149	1245.612	1466.074	1686.536	1906.998	2127.461	65
66	145.5051	365.9673	586.4295	806.8918	1027.354	1247.816	1468.278	1688.741	1909.203	2129.665	66
67	147.7097	368.1719	588.6342	809.0964	1029.559	1250.021	1470.483	1690.945	1911.408	2131.870	67
68	149.9143	370.3766	590.8388	811.3010	1031.763	1252.225	1472.688	1693.150	1913.612	2134.074	68
69	152.1189	372.5812	593.0434	813.5056	1033.968	1254.430	1474.892	1695.355	1915.817	2136.279	69
70	154.3236	374.7858	595.2480	815.7103	1036.173	1256.635	1477.097	1697.559	1918.021	2138.484	70
71	156.5282	376.9904	597.4527	817.9149	1038.377	1258.839	1479.302	1699.764	1920.226	2140.688	71
72	158.7328	379.1950	599.6573	820.1195	1040.582	1261.044	1481.506	1701.968	1922.431	2142.893	72
73	160.9374	381.3997	601.8619	822.3241	1042.786	1263.249	1483.711	1704.173	1924.635	2145.098	73
74	163.1421	383.6043	604.0665	824.5288	1044.991	1265.453	1485.915	1706.378	1926.840	2147.302	74
75	165.3467	385.8089	606.2711	826.7334	1047.196	1267.658	1488.120	1708.582	1929.045	2149.507	75
76	167.5513	388.0135	608.4758	828.9380	1049.400	1269.862	1490.325	1710.787	1931.249	2151.711	76
77	169.7559	390.2182	610.6804	831.1426	1051.605	1272.067	1492.529	1712.992	1933.454	2153.916	77
78	171.9605	392.4228	612.8850	833.3472	1053.809	1274.272	1494.734	1715.196	1935.658	2156.121	78
79	174.1652	394.6274	615.0896	835.5519	1056.014	1276.476	1496.939	1717.401	1937.863	2158.325	79
80	176.3698	396.8320	617.2943	837.7565	1058.219	1278.681	1499.143	1719.605	1940.068	2160.530	80
81	178.5744	399.0366	619.4989	839.9611	1060.423	1280.886	1501.348	1721.810	1942.272	2162.735	81
82	180.7790	401.2413	621.7035	842.1657	1062.628	1283.090	1503.552	1724.015	1944.477	2164.939	82
83	182.9837	403.4459	623.9081	844.3704	1064.833	1285.295	1505.757	1726.219	1946.682	2167.144	83
84	185.1883	405.6505	626.1127	846.5750	1067.037	1287.499	1507.962	1728.424	1948.886	2169.348	84
85	187.3929	407.8551	628.3174	848.7796	1069.242	1289.704	1510.166	1730.629	1951.091	2171.553	85
86	189.5975	410.0598	630.5220	850.9842	1071.446	1291.909	1512.371	1732.833	1953.295	2173.758	86
87	191.8021	412.2644	632.7266	853.1888	1073.651	1294.113	1514.576	1735.038	1955.500	2175.962	87
88	194.0068	414.4690	634.9312	855.3935	1075.856	1296.318	1516.780	1737.242	1957.705	2178.167	88
89	196.2114	416.6736	637.1359	857.5981	1078.060	1298.523	1518.985	1739.447	1959.909	2180.371	89
90	198.4160	418.8782	639.3405	859.8027	1080.265	1300.727	1521.189	1741.652	1962.114	2182.576	90
91	200.6206	421.0829	641.5451	862.0073	1082.470	1302.932	1523.394	1743.856	1964.319	2184.781	91
92	202.8253	423.2875	643.7497	864.2120	1084.674	1305.136	1525.599	1746.061	1966.523	2186.985	92
93	205.0299	425.4921	645.9543	866.4166	1086.879	1307.341	1527.803	1748.266	1968.728	2189.190	93
94	207.2345	427.6967	648.1590	868.6212	1089.083	1309.546	1530.008	1750.470	1970.932	2191.395	94
95	209.4391	429.9014	650.3636	870.8258	1091.288	1311.750	1532.213	1752.675	1973.137	2193.599	95
96	211.6437	432.1060	652.5682	873.0304	1093.493	1313.955	1534.417	1754.879	1975.342	2195.804	96
97	213.8484	434.3106	654.7728	875.2351	1095.697	1316.160	1536.622	1757.084	1977.546	2198.008	97
98	216.0530	436.5152	656.9775	877.4397	1097.902	1318.364	1538.826	1759.289	1979.751	2200.213	98
99	218.2576	438.7198	659.1821	879.6443	1100.107	1320.569	1541.031	1761.493	1981.955	2202.418	99

EQUIVALENTS OF AVOIRDUPOIS POUNDS IN KILOGRAMS

Conversion factor: 1 avoirdupois pound =0.4535924277 kilogram

Pounds	0	100	200	300	400	500	600	700	800	900	Pounds
0		45.3592	90.7185	136.0777	181.4370	226.7962	272.1555	317.5147	362.8739	408.2332	0
1	.4536	45.8128	91.1721	136.5313	181.8906	227.2498	272.6090	317.9683	363.3275	408.6868	1
2	.9072	46.2664	91.6257	136.9849	182.3442	227.7034	273.0626	318.4219	363.7811	409.1404	2
3	1.3608	46.7200	92.0793	137.4385	182.7977	228.1570	273.5162	318.8755	364.2347	409.5940	3
4	1.8144	47.1736	92.5329	137.8921	183.2513	228.6106	273.9698	319.3291	364.6883	410.0476	4
5	2.2680	47.6272	92.9864	138.3457	183.7049	229.0642	274.4234	319.7827	365.1419	410.5011	5
6	2.7216	48.0808	93.4400	138.7993	184.1585	229.5178	274.8770	320.2363	365.5955	410.9547	6
7	3.1751	48.5344	93.8936	139.2529	184.6121	229.9714	275.3306	320.6898	366.0491	411.4083	7
8	3.6287	48.9880	94.3472	139.7065	185.0657	230.4250	275.7842	321.1434	366.5027	411.8619	8
9	4.0823	49.4416	94.8008	140.1601	185.5193	230.8785	276.2378	321.5970	366.9563	412.3155	9
10	4.5359	49.8952	95.2544	140.6137	185.9729	231.3321	276.6914	322.0506	367.4099	412.7691	10
11	4.9895	50.3488	95.7080	141.0672	186.4265	231.7857	277.1450	322.5042	367.8635	413.2227	11
12	5.4431	50.8024	96.1616	141.5208	186.8801	232.2393	277.5986	322.9578	368.3171	413.6763	12
13	5.8967	51.2559	96.6152	141.9744	187.3337	232.6929	278.0522	323.4114	368.7706	414.1299	13
14	6.3503	51.7095	97.0688	142.4280	187.7873	233.1465	278.5058	323.8650	369.2242	414.5835	14
15	6.8039	52.1631	97.5224	142.8816	188.2409	233.6001	278.9593	324.3186	369.6778	415.0371	15
16	7.2575	52.6167	97.9760	143.3352	188.6944	234.0537	279.4129	324.7722	370.1314	415.4907	16
17	7.7111	53.0703	98.4296	143.7888	189.1480	234.5073	279.8665	325.2258	370.5850	415.9443	17
18	8.1647	53.5239	98.8831	144.2424	189.6016	234.9609	280.3201	325.6794	371.0386	416.3978	18
19	8.6183	53.9775	99.3367	144.6960	190.0552	235.4145	280.7737	326.1330	371.4922	416.8514	19
20	9.0718	54.4311	99.7903	145.1496	190.5088	235.8681	281.2273	326.5866	371.9458	417.3050	20
21	9.5254	54.8847	100.2439	145.6032	190.9624	236.3217	281.6809	327.0401	372.3994	417.7586	21
22	9.9790	55.3383	100.6975	146.0568	191.4160	236.7752	282.1345	327.4937	372.8530	418.2122	22
23	10.4326	55.7919	101.1511	146.5104	191.8696	237.2288	282.5881	327.9473	373.3066	418.6658	23
24	10.8862	56.2455	101.6047	146.9639	192.3232	237.6824	283.0417	328.4009	373.7602	419.1194	24
25	11.3398	56.6991	102.0583	147.4175	192.7768	238.1360	283.4953	328.8545	374.2138	419.5730	25
26	11.7934	57.1526	102.5119	147.8711	193.2304	238.5896	283.9489	329.3081	374.6673	420.0266	26
27	12.2470	57.6062	102.9655	148.3247	193.6840	239.0432	284.4025	329.7617	375.1209	420.4802	27
28	12.7006	58.0598	103.4191	148.7783	194.1376	239.4968	284.8560	330.2153	375.5745	420.9338	28
29	13.1542	58.5134	103.8727	149.2319	194.5912	239.9504	285.3096	330.6689	376.0281	421.3874	29
30	13.6078	58.9670	104.3263	149.6855	195.0447	240.4040	285.7632	331.1225	376.4817	421.8410	30
31	14.0614	59.4206	104.7799	150.1391	195.4983	240.8576	286.2168	331.5761	376.9353	422.2946	31
32	14.5150	59.8742	105.2334	150.5927	195.9519	241.3112	286.6704	332.0297	377.3889	422.7481	32
33	14.9686	60.3278	105.6870	151.0463	196.4055	241.7648	287.1240	332.4832	377.8425	423.2017	33
34	15.4221	60.7814	106.1406	151.4999	196.8591	242.2184	287.5776	332.9368	378.2961	423.6553	34
35	15.8757	61.2350	106.5942	151.9535	197.3127	242.6719	288.0312	333.3904	378.7497	424.1089	35
36	16.3293	61.6886	107.0478	152.4071	197.7663	243.1255	288.4848	333.8440	379.2033	424.5625	36
37	16.7829	62.1422	107.5014	152.8607	198.2199	243.5791	288.9384	334.2976	379.6569	425.0161	37
38	17.2365	62.5958	107.9550	153.3142	198.6735	244.0327	289.3920	334.7512	380.1105	425.4697	38
39	17.6901	63.0493	108.4086	153.7678	199.1271	244.4863	289.8456	335.2048	380.5640	425.9233	39
40	18.1437	63.5029	108.8622	154.2214	199.5807	244.9399	290.2992	335.6584	381.0176	426.3769	40
41	18.5973	63.9565	109.3158	154.6750	200.0343	245.3935	290.7528	336.1120	381.4712	426.8305	41
42	19.0509	64.4101	109.7694	155.1286	200.4879	245.8471	291.2063	336.5656	381.9248	427.2841	42
43	19.5045	64.8637	110.2230	155.5822	200.9414	246.3007	291.6599	337.0192	382.3784	427.7377	43
44	19.9581	65.3173	110.6766	156.0358	201.3950	246.7543	292.1135	337.4728	382.8320	428.1913	44
45	20.4117	65.7709	111.1301	156.4894	201.8486	247.2079	292.5671	337.9264	383.2856	428.6448	45
46	20.8653	66.2245	111.5837	156.9430	202.3022	247.6615	293.0207	338.3800	383.7392	429.0984	46
47	21.3188	66.6781	112.0373	157.3966	202.7558	248.1151	293.4743	338.8335	384.1928	429.5520	47
48	21.7724	67.1317	112.4909	157.8502	203.2094	248.5687	293.9279	339.2871	384.6464	430.0056	48
49	22.2260	67.5853	112.9445	158.3038	203.6630	249.0222	294.3815	339.7407	385.1000	430.4592	49

1 oz. =.028350 kg. **2 oz. =.056699 kg.** **3 oz. =.085049 kg.** **4 oz. =.113398 kg.**
5 oz. =.141748 kg. **6 oz. =.170097 kg.** **7 oz. =.198447 kg.** **8 oz. =.226796 kg.**

EQUIVALENTS OF AVOIRDUPOIS POUNDS IN KILOGRAMS

Pounds	0	100	200	300	400	500	600	700	800	900	Pounds
50	22.6796	68.0389	113.3981	158.7573	204.1166	249.4758	294.8351	340.1943	385.5536	430.9128	50
51	23.1332	68.4925	113.8517	159.2109	204.5702	249.9294	295.2887	340.6479	386.0072	431.3664	51
52	23.5868	68.9460	114.3053	159.6645	205.0238	250.3830	295.7423	341.1015	386.4607	431.8200	52
53	24.0404	69.3996	114.7589	160.1181	205.4774	250.8366	296.1959	341.5551	386.9143	432.2736	53
54	24.4940	69.8532	115.2125	160.5717	205.9310	251.2902	296.6494	342.0087	387.3679	432.7272	54
55	24.9476	70.3068	115.6661	161.0253	206.3846	251.7438	297.1030	342.4623	387.8215	433.1808	55
56	25.4012	70.7604	116.1197	161.4789	206.8381	252.1974	297.5566	342.9159	388.2751	433.6344	56
57	25.8548	71.2140	116.5733	161.9325	207.2917	252.6510	298.0102	343.3695	388.7287	434.0880	57
58	26.3084	71.6676	117.0268	162.3861	207.7453	253.1046	298.4638	343.8231	389.1823	434.5415	58
59	26.7620	72.1212	117.4804	162.8397	208.1989	253.5582	298.9174	344.2767	389.6359	434.9951	59
60	27.2155	72.5748	117.9340	163.2933	208.6525	254.0118	299.3710	344.7302	390.0895	435.4487	60
61	27.6691	73.0284	118.3876	163.7469	209.1061	254.4654	299.8246	345.1838	390.5431	435.9023	61
62	28.1227	73.4820	118.8412	164.2005	209.5597	254.9189	300.2782	345.6374	390.9967	436.3559	62
63	28.5763	73.9356	119.2948	164.6541	210.0133	255.3725	300.7318	346.0910	391.4503	436.8095	63
64	29.0299	74.3892	119.7484	165.1076	210.4669	255.8261	301.1854	346.5446	391.9039	437.2631	64
65	29.4835	74.8428	120.2020	165.5612	210.9205	256.2797	301.6390	346.9982	392.3574	437.7167	65
66	29.9371	75.2963	120.6556	166.0148	211.3741	256.7333	302.0926	347.4518	392.8110	438.1703	66
67	30.3907	75.7499	121.1092	166.4684	211.8277	257.1869	302.5461	347.9054	393.2646	438.6239	67
68	30.8443	76.2035	121.5628	166.9220	212.2813	257.6405	302.9997	348.3590	393.7182	439.0775	68
69	31.2979	76.6571	122.0164	167.3756	212.7348	258.0941	303.4533	348.8126	394.1718	439.5311	69
70	31.7515	77.1107	122.4700	167.8292	213.1884	258.5477	303.9069	349.2662	394.6254	439.9847	70
71	32.2051	77.5643	122.9235	168.2828	213.6420	259.0013	304.3605	349.7198	395.0790	440.4382	71
72	32.6587	78.0179	123.3771	168.7364	214.0956	259.4549	304.8141	350.1734	395.5326	440.8918	72
73	33.1122	78.4715	123.8307	169.1900	214.5492	259.9085	305.2677	350.6269	395.9862	441.3454	73
74	33.5658	78.9251	124.2843	169.6436	215.0028	260.3621	305.7213	351.0805	396.4398	441.7990	74
75	34.0194	79.3787	124.7379	170.0972	215.4564	260.8156	306.1749	351.5341	396.8934	442.2526	75
76	34.4730	79.8323	125.1915	170.5508	215.9100	261.2692	306.6285	351.9877	397.3470	442.7062	76
77	34.9266	80.2859	125.6451	171.0043	216.3636	261.7228	307.0821	352.4413	397.8006	443.1598	77
78	35.3802	80.7395	126.0987	171.4579	216.8172	262.1764	307.5357	352.8949	398.2542	443.6134	78
79	35.8338	81.1930	126.5523	171.9115	217.2708	262.6300	307.9893	353.3485	398.7077	444.0670	79
80	36.2874	81.6466	127.0059	172.3651	217.7244	263.0836	308.4429	353.8021	399.1613	444.5206	80
81	36.7410	82.1002	127.4595	172.8187	218.1780	263.5372	308.8964	354.2557	399.6149	444.9742	81
82	37.1946	82.5538	127.9131	173.2723	218.6316	263.9908	309.3500	354.7093	400.0685	445.4278	82
83	37.6482	83.0074	128.3667	173.7259	219.0851	264.4444	309.8036	355.1629	400.5221	445.8814	83
84	38.1018	83.4610	128.8202	174.1795	219.5387	264.8980	310.2572	355.6165	400.9757	446.3349	84
85	38.5554	83.9146	129.2738	174.6331	219.9923	265.3516	310.7108	356.0701	401.4293	446.7885	85
86	39.0089	84.3682	129.7274	175.0867	220.4459	265.8052	311.1644	356.5236	401.8829	447.2421	86
87	39.4625	84.8218	130.1810	175.5403	220.8995	266.2588	311.6180	356.9772	402.3365	447.6957	87
88	39.9161	85.2754	130.6346	175.9939	221.3531	266.7123	312.0716	357.4308	402.7901	448.1493	88
89	40.3697	85.7290	131.0882	176.4475	221.8067	267.1659	312.5252	357.8844	403.2437	448.6029	89
90	40.8233	86.1826	131.5418	176.9010	222.2603	267.6195	312.9788	358.3380	403.6973	449.0565	90
91	41.2769	86.6362	131.9954	177.3546	222.7139	268.0731	313.4324	358.7916	404.1509	449.5101	91
92	41.7305	87.0897	132.4490	177.8082	223.1675	268.5267	313.8860	359.2452	404.6044	449.9637	92
93	42.1841	87.5433	132.9026	178.2618	223.6211	268.9803	314.3396	359.6988	405.0580	450.4173	93
94	42.6377	87.9969	133.3562	178.7154	224.0747	269.4339	314.7931	360.1524	405.5116	450.8709	94
95	43.0913	88.4505	133.8098	179.1690	224.5283	269.8875	315.2467	360.6060	405.9652	451.3245	95
96	43.5449	88.9041	134.2634	179.6226	224.9818	270.3411	315.7003	361.0596	406.4188	451.7781	96
97	43.9985	89.3577	134.7170	180.0762	225.4354	270.7947	316.1539	361.5132	406.8724	452.2317	97
98	44.4521	89.8113	135.1705	180.5298	225.8890	271.2483	316.6075	361.9668	407.3260	452.6852	98
99	44.9057	90.2649	135.6241	180.9834	226.3426	271.7019	317.0611	362.4203	407.7796	453.1388	99

9 oz. = .255146 kg. **10 oz. = .283495 kg.** **11 oz. = .311845 kg.** **12 oz. = .340194 kg.**
13 oz. = .368544 kg. **14 oz. = .396893 kg.** **15 oz. = .425243 kg.** **16 oz. = .453592 kg.**

CENTIMETER—INCH INTERCONVERSION TABLE

1 INCH = 2.540005080 CM. 1 CM. = .3937 INCHES (U. S. STATUTE)

Centimeters	In. / Cm.	Inches	Centimeters	In. / Cm.	Inches	Centimeters	In. / Cm.	Inches
.050800	.02	.007874	2.54001	1	.3937	129.54026	51	20.0787
.101600	.04	.015748	5.08001	2	.7874	132.08026	52	20.4724
.152400	.06	.023622	7.62002	3	1.1811	134.62027	53	20.8661
.203200	.08	.031496	10.16002	4	1.5748	137.16027	54	21.2598
.254001	.10	.039370	12.70003	5	1.9685	139.70028	55	21.6535
.304801	.12	.047244	15.24003	6	2.3622	142.24028	56	22.0472
.355601	.14	.055118	17.78004	7	2.7559	144.78029	57	22.4409
.406401	.16	.062992	20.32004	8	3.1496	147.32029	58	22.8346
.457201	.18	.070866	22.86005	9	3.5433	149.86030	59	23.2283
.508001	.20	.078740	25.40005	10	3.9370	152.40030	60	23.6220
.558801	.22	.086614	27.94006	11	4.3307	154.94031	61	24.0157
.609601	.24	.094488	30.48006	12	4.7244	157.48031	62	24.4094
.660401	.26	.102362	33.02007	13	5.1181	160.02032	63	24.8031
.711201	.28	.110236	35.56007	14	5.5118	162.56033	64	25.1968
.762002	.30	.118110	38.10008	15	5.9055	165.10033	65	25.5905
.812802	.32	.125984	40.64008	16	6.2992	167.64034	66	25.9842
.863602	.34	.133858	43.18009	17	6.6929	170.18034	67	26.3779
.914402	.36	.141732	45.72009	18	7.0866	172.72035	68	26.7716
.965202	.38	.149606	48.26010	19	7.4803	175.26035	69	27.1653
1.016002	.40	.157480	50.80010	20	7.8740	177.80036	70	27.5590
1.066802	.42	.165354	53.34011	21	8.2677	180.34036	71	27.9527
1.117602	.44	.173228	55.88011	22	8.6614	182.88037	72	28.3464
1.168402	.46	.181102	58.42012	23	9.0551	185.42037	73	28.7401
1.219202	.48	.188976	60.96012	24	9.4488	187.96038	74	29.1338
1.270003	.50	.196850	63.50013	25	9.8425	190.50038	75	29.5275
1.320803	.52	.204724	66.04013	26	10.2362	193.04039	76	29.9212
1.371603	.54	.212598	68.58014	27	10.6299	195.58039	77	30.3149
1.422403	.56	.220472	71.12014	28	11.0236	198.12040	78	30.7086
1.473203	.58	.228346	73.66015	29	11.4173	200.66040	79	31.1023
1.524003	.60	.236220	76.20015	30	11.8110	203.20041	80	31.4960
1.574803	.62	.244094	78.74016	31	12.2047	205.74041	81	31.8897
1.625603	.64	.251968	81.28016	32	12.5984	208.28042	82	32.2834
1.676403	.66	.259842	83.82017	33	12.9921	210.82042	83	32.6771
1.727203	.68	.267716	86.36017	34	13.3858	213.36043	84	33.0708
1.778004	.70	.275590	88.90018	35	13.7795	215.90043	85	33.4645
1.828804	.72	.283464	91.44018	36	14.1732	218.44044	86	33.8582
1.879604	.74	.291338	93.98019	37	14.5669	220.98044	87	34.2519
1.930404	.76	.299212	96.52019	38	14.9606	223.52045	88	34.6456
1.981204	.78	.307086	99.06020	39	15.3543	226.06045	89	35.0393
2.032004	.80	.314960	101.60020	40	15.7480	228.60046	90	35.4330
2.082804	.82	.322834	104.14021	41	16.1417	231.14046	91	35.8267
2.133604	.84	.330708	106.68021	42	16.5354	233.68047	92	36.2204
2.184404	.86	.338582	109.22022	43	16.9291	236.22047	93	36.6141
2.235204	.88	.346456	111.76022	44	17.3228	238.76048	94	37.0078
2.286005	.90	.354330	114.30023	45	17.7165	241.30048	95	37.4015
2.336805	.92	.362204	116.84023	46	18.1102	243.84049	96	37.7952
2.387605	.94	.370078	119.38024	47	18.5039	246.38049	97	38.1889
2.438405	.96	.377952	121.92024	48	18.8976	248.92050	98	38.5826
2.489205	.98	.385826	124.46025	49	19.2913	251.46050	99	38.9763
2.540005	1.00	.393700	127.00025	50	19.6850	254.00051	100	39.3700

Look up value to be converted in middle column. If in inches, read centimeter equivalent in left column; if in centimeters, read inch equivalent in right column.

COMPARISON OF THE VARIOUS TONS AND POUNDS IN USE IN THE UNITED STATES

Troy Pounds	Avoirdupois Pounds	Kilograms	Short Tons	Long Tons	Metric Tons
1	.822 857	.373 24	.000 411 43	.000 367 35	.000 373 24
2	1.645 71	.746 48	.000 822 86	.000 734 69	.000 746 48
3	2.468 57	1.119 73	.001 234 29	.001 102 04	.001 119 73
4	3.291 43	1.492 97	.001 645 71	.001 469 39	.001 492 97
5	4.114 29	1.866 21	.002 057 14	.001 836 73	.001 866 21
6	4.937 14	2.239 45	.002 468 57	.002 204 08	.002 239 45
7	5.760 00	2.612 69	.002 880 00	.002 571 43	.002 612 69
8	6.582 86	2.985 93	.003 291 43	.002 938 78	.002 985 93
9	7.405 71	3.359 18	.003 702 86	.003 306 12	.003 359 18
1.215 28	**1**	.453 59	.0005	.000 446 43	.000 453 59
2.430 56	**2**	.907 18	.0010	.000 892 86	.000 907 18
3.645 83	**3**	1.360 78	.0015	.001 339 29	.001 360 78
4.861 11	**4**	1.814 37	.0020	.001 785 71	.001 814 37
6.076 39	**5**	2.267 96	.0025	.002 232 14	.002 267 96
7.291 67	**6**	2.721 55	.0030	.002 678 57	.002 721 55
8.506 94	**7**	3.175 15	.0035	.003 125 00	.003 175 15
9.722 22	**8**	3.628 74	.0040	.003 571 43	.003 628 74
10.937 50	**9**	4.082 33	.0045	.004 017 86	.004 082 33
2.679 23	2.204 62	**1**	.001 102 31	.000 984 21	.001
5.358 46	4.409 24	**2**	.002 204 62	.001 968 41	.002
8.037 69	6.613 87	**3**	.003 306 93	.002 952 62	.003
10.716 91	8.818 49	**4**	.004 409 24	.003 936 83	.004
13.396 14	11.023 11	**5**	.005 511 56	.004 921 03	.005
16.075 37	13.227 73	**6**	.006 613 87	.005 905 24	.006
18.754 60	15.432 36	**7**	.007 716 18	.006 889 44	.007
21.433 83	17.636 98	**8**	.008 818 49	.007 873 65	.008
24.113 06	19.841 60	**9**	.009 920 80	.008 857 86	.009
2430.56	2000	907.18	**1**	.892 86	.907 18
4861.11	4000	1814.37	**2**	1.785 71	1.814 37
7291.67	6000	2721.55	**3**	2.678 57	2.721 55
9722.22	8000	3628.74	**4**	3.571 43	3.628 74
12 152.78	10 000	4535.92	**5**	4.464 29	4.535 92
14 583.33	12 000	5443.11	**6**	5.357 14	5.443 11
17 013.89	14 000	6350.29	**7**	6.250 00	6.350 29
19 444.44	16 000	7257.48	**8**	7.142 86	7.257 48
21 875.00	18 000	8164.66	**9**	8.035 71	8.164 66
2722.22	2240	1016.05	1.12	**1**	1.016 05
5444.44	4480	2032.09	2.24	**2**	2.032 09
8166.67	6720	3048.14	3.36	**3**	3.048 14
10 888.89	8960	4064.19	4.48	**4**	4.064 19
13 611.11	11 200	5080.24	5.60	**5**	5.080 24
16 333.33	13 440	6096.28	6.72	**6**	6.096 28
19 055.56	15 680	7112.33	7.84	**7**	7.112 33
21 777.78	17 920	8128.38	8.96	**8**	8.128 38
24 500.00	20 160	9144.42	10.08	**9**	9.144 42
2679.23	2204.62	1000	1.102 31	.984 21	**1**
5358.46	4409.24	2000	2.204 62	1.968 41	**2**
8037.69	6613.87	3000	3.306 93	2.952 62	**3**
10 716.91	8818.49	4000	4.409 24	3.936 83	**4**
13 396.14	11 023.11	5000	5.511 56	4.921 03	**5**
16 075.37	13 227.73	6000	6.613 87	5.905 24	**6**
18 754.60	15 432.36	7000	7.716 18	6.889 44	**7**
21 433.83	17 636.98	8000	8.818 49	7.873 65	**8**
24 113.06	19 841.60	9000	9.920 80	8.857 86	**9**

TEMPERATURE CONVERSION TABLES

Albert Sauveur type of table. Values revised.

—459.4 to 0			0 to 100						100 to 1000					
C	F \ C	F	C	F \ C	F	C	F \ C	F	C	F \ C	F	C	F \ C	F
–273	*–459.4*		–17.8	*0*	32	10.0	*50*	122.0	38	*100*	212	260	*500*	932
–268	*–450*		–17.2	*1*	33.8	10.6	*51*	123.8	43	*110*	230	266	*510*	950
–262	*–440*		–16.7	*2*	35.6	11.1	*52*	125.6	49	*120*	248	271	*520*	968
–257	*–430*		–16.1	*3*	37.4	11.7	*53*	127.4	54	*130*	266	277	*530*	986
–251	*–420*		–15.6	*4*	39.2	12.2	*54*	129.2	60	*140*	284	282	*540*	1004
–246	*–410*		–15.0	*5*	41.0	12.8	*55*	131.0	66	*150*	302	288	*550*	1022
–240	*–400*		–14.4	*6*	42.8	13.3	*56*	132.8	71	*160*	320	293	*560*	1040
–234	*–390*		–13.9	*7*	44.6	13.9	*57*	134.6	77	*170*	338	299	*570*	1058
–229	*–380*		–13.3	*8*	46.4	14.4	*58*	136.4	82	*180*	356	304	*580*	1076
–223	*–370*		–12.8	*9*	48.2	15.0	*59*	138.2	88	*190*	374	310	*590*	1094
–218	*–360*		–12.2	*10*	50.0	15.6	*60*	140.0	93	*200*	392	316	*600*	1112
–212	*–350*		–11.7	*11*	51.8	16.1	*61*	141.8	99	*210*	410	321	*610*	1130
–207	*–340*		–11.1	*12*	53.6	16.7	*62*	143.6	100	*212*	413.6	327	*620*	1148
–201	*–330*		–10.6	*13*	55.4	17.2	*63*	145.4	104	*220*	428	332	*630*	1166
–196	*–320*		–10.0	*14*	57.2	17.8	*64*	147.2	110	*230*	446	338	*640*	1184
–190	*–310*		– 9.4	*15*	59.0	18.3	*65*	149.0	116	*240*	464	343	*650*	1202
–184	*–300*		– 8.9	*16*	60.8	18.9	*66*	150.8	121	*250*	482	349	*660*	1220
–179	*–290*		– 8.3	*17*	62.6	19.4	*67*	152.6	127	*260*	500	354	*670*	1238
–173	*–280*		– 7.8	*18*	64.4	20.0	*68*	154.4	132	*270*	518	360	*680*	1256
–169	*–273*	–459.4	– 7.2	*19*	66.2	20.6	*69*	156.2	138	*280*	536	366	*690*	1274
–168	*–270*	–454	– 6.7	*20*	68.0	21.1	*70*	158.0	143	*290*	554	371	*700*	1292
–162	*–260*	–436	– 6.1	*21*	69.8	21.7	*71*	159.8	149	*300*	572	377	*710*	1310
–157	*–250*	–418	– 5.6	*22*	71.6	22.2	*72*	161.6	154	*310*	590	382	*720*	1328
–151	*–240*	–400	– 5.0	*23*	73.4	22.8	*73*	163.4	160	*320*	608	388	*730*	1346
–146	*–230*	–382	– 4.4	*24*	75.2	23.3	*74*	165.2	166	*330*	626	393	*740*	1364
–140	*–220*	–364	– 3.9	*25*	77.0	23.9	*75*	167.0	171	*340*	644	399	*750*	1382
–134	*–210*	–346	– 3.3	*26*	78.8	24.4	*76*	168.8	177	*350*	662	404	*760*	1400
–129	*–200*	–328	– 2.8	*27*	80.6	25.0	*77*	170.6	182	*360*	680	410	*770*	1418
–123	*–190*	–310	– 2.2	*28*	82.4	25.6	*78*	172.4	188	*370*	698	416	*780*	1436
–118	*–180*	–292	– 1.7	*29*	84.2	26.1	*79*	174.2	193	*380*	716	421	*790*	1454
–112	*–170*	–274	– 1.1	*30*	86.0	26.7	*80*	176.0	199	*390*	734	427	*800*	1472
–107	*–160*	–256	– .6	*31*	87.8	27.2	*81*	177.8	204	*400*	752	432	*810*	1490
–101	*–150*	–238	0	*32*	89.6	27.8	*82*	179.6	210	*410*	770	438	*820*	1508
– 96	*–140*	–220	.6	*33*	91.4	28.3	*83*	181.4	216	*420*	788	443	*830*	1526
– 90	*–130*	–202	1.1	*34*	93.2	28.9	*84*	183.2	221	*430*	806	449	*840*	1544
– 84	*–120*	–184	1.7	*35*	95.0	29.4	*85*	185.0	227	*440*	824	454	*850*	1562
– 79	*–110*	–166	2.2	*36*	96.8	30.0	*86*	186.8	232	*450*	842	460	*860*	1580
– 73	*–100*	–148	2.8	*37*	98.6	30.6	*87*	188.6	238	*460*	860	466	*870*	1598
– 68	*– 90*	–130	3.3	*38*	100.4	31.1	*88*	190.4	243	*470*	878	471	*880*	1616
– 62	*– 80*	–112	3.9	*39*	102.2	31.7	*89*	192.2	249	*480*	896	477	*890*	1634
– 57	*– 70*	– 94	4.4	*40*	104.0	32.2	*90*	194.0	254	*490*	914	482	*900*	1652
– 51	*– 60*	– 76	5.0	*41*	105.8	32.8	*91*	195.8				488	*910*	1670
– 46	*– 50*	– 58	5.6	*42*	107.6	33.3	*92*	197.6				493	*920*	1688
– 40	*– 40*	– 40	6.1	*43*	109.4	33.9	*93*	199.4				499	*930*	1706
– 34	*– 30*	– 22	6.7	*44*	111.2	34.4	*94*	201.2				504	*940*	1724
– 29	*– 20*	– 4	7.2	*45*	113.0	35.0	*95*	203.0				510	*950*	1742
– 23	*– 10*	14	7.8	*46*	114.8	35.6	*96*	204.8				516	*960*	1760
– 17.8	*0*	32	8.3	*47*	116.6	36.1	*97*	206.6				521	*970*	1778
			8.9	*48*	118.4	36.7	*98*	208.4				527	*980*	1796
			9.4	*49*	120.2	37.2	*99*	210.2				532	*990*	1814
						37.8	*100*	212.0				538	*1000*	1832

Look up reading in middle column. If in degrees Centigrade, read Fahrenheit equivalent in right hand column; if in Fahrenheit degrees, read Centigrade equivalent in left hand column.

TEMPERATURE CONVERSION TABLES

Albert Sauveur type of table. Values revised.

1000 to 2000						2000 to 3000					
C	F \ C	F	C	F \ C	F	C	F \ C	F	C	F \ C	F
538	*1000*	1832	816	*1500*	2732	1093	*2000*	3632	1371	*2500*	4532
543	*1010*	1850	821	*1510*	2750	1099	*2010*	3650	1377	*2510*	4550
549	*1020*	1868	827	*1520*	2768	1104	*2020*	3668	1382	*2520*	4568
554	*1030*	1886	832	*1530*	2786	1110	*2030*	3686	1388	*2530*	4586
560	*1040*	1904	838	*1540*	2804	1116	*2040*	3704	1393	*2540*	4604
566	*1050*	1922	843	*1550*	2822	1121	*2050*	3722	1399	*2550*	4622
571	*1060*	1940	849	*1560*	2840	1127	*2060*	3740	1404	*2560*	4640
577	*1070*	1958	854	*1570*	2858	1132	*2070*	3758	1410	*2570*	4658
582	*1080*	1976	860	*1580*	2876	1138	*2080*	3776	1416	*2580*	4676
588	*1090*	1994	866	*1590*	2894	1143	*2090*	3794	1421	*2590*	4694
593	*1100*	2012	871	*1600*	2912	1149	*2100*	3812	1427	*2600*	4712
599	*1110*	2030	877	*1610*	2930	1154	*2110*	3830	1432	*2610*	4730
604	*1120*	2048	882	*1620*	2948	1160	*2120*	3848	1438	*2620*	4748
610	*1130*	2066	888	*1630*	2966	1166	*2130*	3866	1443	*2630*	4766
616	*1140*	2084	893	*1640*	2984	1171	*2140*	3884	1449	*2640*	4784
621	*1150*	2102	899	*1650*	3002	1177	*2150*	3902	1454	*2650*	4802
627	*1160*	2120	904	*1660*	3020	1182	*2160*	3920	1460	*2660*	4820
632	*1170*	2138	910	*1670*	3038	1188	*2170*	3938	1466	*2670*	4838
638	*1180*	2156	916	*1680*	3056	1193	*2180*	3956	1471	*2680*	4856
643	*1190*	2174	921	*1690*	3074	1199	*2190*	3974	1477	*2690*	4874
649	*1200*	2192	927	*1700*	3092	1204	*2200*	3992	1482	*2700*	4892
654	*1210*	2210	932	*1710*	3110	1210	*2210*	4010	1488	*2710*	4910
660	*1220*	2228	938	*1720*	3128	1216	*2220*	4028	1493	*2720*	4928
666	*1230*	2246	943	*1730*	3146	1221	*2230*	4046	1499	*2730*	4946
671	*1240*	2264	949	*1740*	3164	1227	*2240*	4064	1504	*2740*	4964
677	*1250*	2282	954	*1750*	3182	1232	*2250*	4082	1510	*2750*	4982
682	*1260*	2300	960	*1760*	3200	1238	*2260*	4100	1516	*2760*	5000
688	*1270*	2318	966	*1770*	3218	1243	*2270*	4118	1521	*2770*	5018
693	*1280*	2336	971	*1780*	3236	1249	*2280*	4136	1527	*2780*	5036
699	*1290*	2354	977	*1790*	3254	1254	*2290*	4154	1532	*2790*	5054
704	*1300*	2372	982	*1800*	3272	1260	*2300*	4172	1538	*2800*	5072
710	*1310*	2390	988	*1810*	3290	1266	*2310*	4190	1543	*2810*	5090
716	*1320*	2408	993	*1820*	3308	1271	*2320*	4208	1549	*2820*	5108
721	*1330*	2426	999	*1830*	3326	1277	*2330*	4226	1554	*2830*	5126
727	*1340*	2444	1004	*1840*	3344	1282	*2340*	4244	1560	*2840*	5144
732	*1350*	2462	1010	*1850*	3362	1288	*2350*	4262	1566	*2850*	5162
738	*1360*	2480	1016	*1860*	3380	1293	*2360*	4280	1571	*2860*	5180
743	*1370*	2498	1021	*1870*	3398	1299	*2370*	4298	1577	*2870*	5198
749	*1380*	2516	1027	*1880*	3416	1304	*2380*	4316	1582	*2880*	5216
754	*1390*	2534	1032	*1890*	3434	1310	*2390*	4334	1588	*2890*	5234
760	*1400*	2552	1038	*1900*	3452	1316	*2400*	4352	1593	*2900*	5252
766	*1410*	2570	1043	*1910*	3470	1321	*2410*	4370	1599	*2910*	5270
771	*1420*	2588	1049	*1920*	3488	1327	*2420*	4388	1604	*2920*	5288
777	*1430*	2606	1054	*1930*	3506	1332	*2430*	4406	1610	*2930*	5306
782	*1440*	2624	1060	*1940*	3524	1338	*2440*	4424	1616	*2940*	5324
788	*1450*	2642	1066	*1950*	3542	1343	*2450*	4442	1621	*2950*	5342
793	*1460*	2660	1071	*1960*	3560	1349	*2460*	4460	1627	*2960*	5360
799	*1470*	2678	1077	*1970*	3578	1354	*2470*	4478	1632	*2970*	5378
804	*1480*	2696	1082	*1980*	3596	1360	*2480*	4496	1638	*2980*	5396
810	*1490*	2714	1088	*1990*	3614	1366	*2490*	4514	1643	*2990*	5414
			1093	*2000*	3632				1649	*3000*	5432

Look up reading in middle column. If in degrees Centigrade, read Fahrenheit equivalent in right hand column; if in degrees Fahrenheit, read Centigrade equivalent in left hand column.

.01
.49

FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
.01	.0001	.000001	0.1000	0.2154	$\bar{2}.00000$	100000.000	.03142	.000079
.02	.0004	.000008	0.1414	0.2714	$\bar{2}.30103$	50000.000	.06283	.000314
.03	.0009	.000027	0.1732	0.3107	$\bar{2}.47712$	33333.333	.09425	.000707
.04	.0016	.000064	0.2000	0.3420	$\bar{2}.60206$	25000.000	.12566	.001257
.05	.0025	.000125	0.2236	0.3684	$\bar{2}.69897$	20000.000	.15708	.001963
.06	.0036	.000216	0.2449	0.3915	$\bar{2}.77815$	16666.667	.18850	.002827
.07	.0049	.000343	0.2646	0.4121	$\bar{2}.84510$	14285.714	.21991	.003848
.08	.0064	.000512	0.2828	0.4309	$\bar{2}.90309$	12500.000	.25133	.005027
.09	.0081	.000729	0.3000	0.4481	$\bar{2}.95424$	11111.111	.28274	.006362
.10	.0100	.001000	0.3162	0.4642	$\bar{1}.00000$	10000.000	.31416	.007854
.11	.0121	.001331	0.3317	0.4791	$\bar{1}.04139$	9090.909	.34558	.009503
.12	.0144	.001728	0.3464	0.4932	$\bar{1}.07918$	8333.333	.37699	.011310
.13	.0169	.002197	0.3606	0.5066	$\bar{1}.11394$	7692.308	.40841	.013273
.14	.0196	.002744	0.3742	0.5192	$\bar{1}.14613$	7142.857	.43982	.015394
.15	.0225	.003375	0.3873	0.5313	$\bar{1}.17609$	6666.667	.47124	.017671
.16	.0256	.004096	0.4000	0.5429	$\bar{1}.20412$	6250.000	.50265	.020106
.17	.0289	.004913	0.4123	0.5540	$\bar{1}.23045$	5882.353	.53407	.022698
.18	.0324	.005832	0.4243	0.5646	$\bar{1}.25527$	5555.556	.56549	.025447
.19	.0361	.006859	0.4359	0.5749	$\bar{1}.27875$	5263.158	.59690	.028353
.20	.0400	.008000	0.4472	0.5848	$\bar{1}.30103$	5000.000	.62832	.031416
.21	.0441	.009261	0.4583	0.5944	$\bar{1}.32222$	4761.905	.65973	.034636
.22	.0484	.010648	0.4690	0.6037	$\bar{1}.34242$	4545.455	.69115	.038013
.23	.0529	.012167	0.4796	0.6127	$\bar{1}.36173$	4347.826	.72257	.041548
.24	.0576	.013824	0.4899	0.6214	$\bar{1}.38021$	4166.667	.75398	.045239
.25	.0625	.015625	0.5000	0.6300	$\bar{1}.39794$	4000.000	.78540	.049087
.26	.0676	.017576	0.5099	0.6383	$\bar{1}.41497$	3846.154	.81681	.053093
.27	.0729	.019683	0.5196	0.6463	$\bar{1}.43136$	3703.704	.84823	.057256
.28	.0784	.021952	0.5292	0.6542	$\bar{1}.44716$	3571.429	.87965	.061575
.29	.0841	.024389	0.5385	0.6619	$\bar{1}.46240$	3448.276	.91106	.066052
.30	.0900	.027000	0.5477	0.6694	$\bar{1}.47712$	3333.333	.94248	.070686
.31	.0961	.029791	0.5568	0.6768	$\bar{1}.49136$	3225.807	.97389	.075477
.32	.1024	.032768	0.5657	0.6840	$\bar{1}.50515$	3125.000	1.00531	.080425
.33	.1089	.035937	0.5745	0.6910	$\bar{1}.51851$	3030.303	1.03673	.085530
.34	.1156	.039304	0.5831	0.6980	$\bar{1}.53148$	2941.177	1.06814	.090792
.35	.1225	.042875	0.5916	0.7047	$\bar{1}.54407$	2857.143	1.09956	.096211
.36	.1296	.046656	0.6000	0.7114	$\bar{1}.55630$	2777.778	1.13097	.101788
.37	.1369	.050653	0.6083	0.7179	$\bar{1}.56820$	2702.703	1.16239	.107521
.38	.1444	.054872	0.6164	0.7243	$\bar{1}.57978$	2631.579	1.19381	.113411
.39	.1521	.059319	0.6245	0.7306	$\bar{1}.59106$	2564.103	1.22522	.119459
.40	.1600	.064000	0.6325	0.7368	$\bar{1}.60206$	2500.000	1.2566	.125664
.41	.1681	.068921	0.6403	0.7429	$\bar{1}.61278$	2439.024	1.2881	.132025
.42	.1764	.074088	0.6481	0.7489	$\bar{1}.62325$	2380.952	1.3195	.138544
.43	.1849	.079507	0.6557	0.7548	$\bar{1}.63347$	2325.581	1.3509	.145220
.44	.1936	.085184	0.6633	0.7606	$\bar{1}.64345$	2272.727	1.3823	.152053
.45	.2025	.091125	0.6708	0.7663	$\bar{1}.65321$	2222.222	1.4137	.159043
.46	.2116	.097336	0.6782	0.7719	$\bar{1}.66276$	2173.913	1.4451	.166190
.47	.2209	.103823	0.6856	0.7775	$\bar{1}.67210$	2127.660	1.4765	.173494
.48	.2304	.110592	0.6928	0.7830	$\bar{1}.68124$	2083.333	1.5080	.180956
.49	.2401	.117649	0.7000	0.7884	$\bar{1}.69020$	2040.816	1.5394	.188574

FUNCTIONS OF NUMBERS

.50
.99

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
.50	.2500	.125000	0.7071	0.7937	$\bar{1}.69897$	2000.000	1.5708	.19635
.51	.2601	.132651	0.7141	0.7990	$\bar{1}.70757$	1960.784	1.6022	.20428
.52	.2704	.140608	0.7211	0.8041	$\bar{1}.71600$	1923.077	1.6336	.21237
.53	.2809	.148877	0.7280	0.8093	$\bar{1}.72428$	1886.793	1.6650	.22062
.54	.2916	.157464	0.7348	0.8143	$\bar{1}.73239$	1851.852	1.6965	.22902
.55	.3025	.166375	0.7416	0.8193	$\bar{1}.74036$	1818.182	1.7279	.23758
.56	.3136	.175616	0.7483	0.8243	$\bar{1}.74819$	1785.714	1.7593	.24630
.57	.3249	.185193	0.7550	0.8291	$\bar{1}.75587$	1754.386	1.7907	.25518
.58	.3364	.195112	0.7616	0.8340	$\bar{1}.76343$	1724.138	1.8221	.26421
.59	.3481	.205379	0.7681	0.8387	$\bar{1}.77085$	1694.915	1.8535	.27340
.60	.3600	.216000	0.7746	0.8434	$\bar{1}.77815$	1666.667	1.8850	.28274
.61	.3721	.226981	0.7810	0.8481	$\bar{1}.78533$	1639.344	1.9164	.29225
.62	.3844	.238328	0.7874	0.8527	$\bar{1}.79239$	1612.903	1.9478	.30191
.63	.3969	.250047	0.7937	0.8573	$\bar{1}.79934$	1587.302	1.9792	.31172
.64	.4096	.262144	0.8000	0.8618	$\bar{1}.80618$	1562.500	2.0106	.32170
.65	.4225	.274625	0.8062	0.8662	$\bar{1}.81291$	1538.462	2.0420	.33183
.66	.4356	.287496	0.8124	0.8707	$\bar{1}.81954$	1515.152	2.0735	.34212
.67	.4489	.300763	0.8185	0.8750	$\bar{1}.82607$	1492.537	2.1049	.35257
.68	.4624	.314432	0.8246	0.8794	$\bar{1}.83251$	1470.588	2.1363	.36317
.69	.4761	.328509	0.8307	0.8837	$\bar{1}.83885$	1449.275	2.1677	.37393
.70	.4900	.343000	0.8367	0.8879	$\bar{1}.84510$	1428.571	2.1991	.38485
.71	.5041	.357911	0.8426	0.8921	$\bar{1}.85126$	1408.451	2.2305	.39592
.72	.5184	.373248	0.8485	0.8963	$\bar{1}.85733$	1388.889	2.2619	.40715
.73	.5329	.389017	0.8544	0.9004	$\bar{1}.86332$	1369.863	2.2934	.41854
.74	.5476	.405224	0.8602	0.9045	$\bar{1}.86923$	1351.351	2.3248	.43008
.75	.5625	.421875	0.8660	0.9086	$\bar{1}.87506$	1333.333	2.3562	.44179
.76	.5776	.438976	0.8718	0.9126	$\bar{1}.88081$	1315.790	2.3876	.45365
.77	.5929	.456533	0.8775	0.9166	$\bar{1}.88649$	1298.701	2.4190	.46566
.78	.6084	.474552	0.8832	0.9205	$\bar{1}.89209$	1282.051	2.4504	.47784
.79	.6241	.493039	0.8888	0.9244	$\bar{1}.89763$	1265.823	2.4819	.49017
.80	.6400	.512000	0.8944	0.9283	$\bar{1}.90309$	1250.000	2.5133	.50265
.81	.6561	.531441	0.9000	0.9322	$\bar{1}.90849$	1234.568	2.5447	.51530
.82	.6724	.551368	0.9055	0.9360	$\bar{1}.91381$	1219.512	2.5761	.52810
.83	.6889	.571787	0.9110	0.9398	$\bar{1}.91908$	1204.819	2.6075	.54106
.84	.7056	.592704	0.9165	0.9435	$\bar{1}.92428$	1190.476	2.6389	.55418
.85	.7225	.614125	0.9220	0.9473	$\bar{1}.92942$	1176.471	2.6704	.56745
.86	.7396	.636056	0.9274	0.9510	$\bar{1}.93450$	1162.791	2.7018	.58088
.87	.7569	.658503	0.9327	0.9546	$\bar{1}.93952$	1149.425	2.7332	.59447
.88	.7744	.681472	0.9381	0.9583	$\bar{1}.94448$	1136.364	2.7646	.60821
.89	.7921	.704969	0.9434	0.9619	$\bar{1}.94939$	1123.596	2.7960	.62211
.90	.8100	.729000	0.9487	0.9655	$\bar{1}.95424$	1111.111	2.8274	.63617
.91	.8281	.753571	0.9539	0.9691	$\bar{1}.95904$	1098.901	2.8588	.65039
.92	.8464	.778688	0.9592	0.9726	$\bar{1}.96379$	1086.957	2.8903	.66476
.93	.8649	.804357	0.9644	0.9761	$\bar{1}.96848$	1075.269	2.9217	.67929
.94	.8836	.830584	0.9695	0.9796	$\bar{1}.97313$	1063.830	2.9531	.69398
.95	.9025	.857375	0.9747	0.9830	$\bar{1}.97772$	1052.632	2.9845	.70882
.96	.9216	.884736	0.9798	0.9865	$\bar{1}.98227$	1041.667	3.0159	.72382
.97	.9409	.912673	0.9849	0.9899	$\bar{1}.98677$	1030.928	3.0473	.73898
.98	.9604	.941192	0.9899	0.9933	$\bar{1}.99123$	1020.408	3.0788	.75430
.99	.9801	.970299	0.9950	0.9967	$\bar{1}.99564$	1010.101	3.1102	.76977

1
49

FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
1	1	1	1.0000	1.0000	0.00000	1000.000	3.142	0.7854
2	4	8	1.4142	1.2599	0.30103	500.000	6.283	3.1416
3	9	27	1.7321	1.4422	0.47712	333.333	9.425	7.0686
4	16	64	2.0000	1.5874	0.60206	250.000	12.566	12.5664
5	25	125	2.2361	1.7100	0.69897	200.000	15.708	19.6350
6	36	216	2.4495	1.8171	0.77815	166.667	18.850	28.2743
7	49	343	2.6458	1.9129	0.84510	142.857	21.991	38.4845
8	64	512	2.8284	2.0000	0.90309	125.000	25.133	50.2655
9	81	729	3.0000	2.0801	0.95424	111.111	28.274	63.6173
10	100	1000	3.1623	2.1544	1.00000	100.000	31.416	78.5398
11	121	1331	3.3166	2.2240	1.04139	90.9091	34.558	95.0332
12	144	1728	3.4641	2.2894	1.07918	83.3333	37.699	113.097
13	169	2197	3.6056	2.3513	1.11394	76.9231	40.841	132.732
14	196	2744	3.7417	2.4101	1.14613	71.4286	43.982	153.938
15	225	3375	3.8730	2.4662	1.17609	66.6667	47.124	176.715
16	256	4096	4.0000	2.5198	1.20412	62.5000	50.265	201.062
17	289	4913	4.1231	2.5713	1.23045	58.8235	53.407	226.980
18	324	5832	4.2426	2.6207	1.25527	55.5556	56.549	254.469
19	361	6859	4.3589	2.6684	1.27875	52.6316	59.690	283.529
20	400	8000	4.4721	2.7144	1.30103	50.0000	62.832	314.159
21	441	9261	4.5826	2.7589	1.32222	47.6190	65.973	346.361
22	484	10648	4.6904	2.8020	1.34242	45.4545	69.115	380.133
23	529	12167	4.7958	2.8439	1.36173	43.4783	72.257	415.476
24	576	13824	4.8990	2.8845	1.38021	41.6667	75.398	452.389
25	625	15625	5.0000	2.9240	1.39794	40.0000	78.540	490.874
26	676	17576	5.0990	2.9625	1.41497	38.4615	81.681	530.929
27	729	19683	5.1962	3.0000	1.43136	37.0370	84.823	572.555
28	784	21952	5.2915	3.0366	1.44716	35.7143	87.965	615.752
29	841	24389	5.3852	3.0723	1.46240	34.4828	91.106	660.520
30	900	27000	5.4772	3.1072	1.47712	33.3333	94.248	706.858
31	961	29791	5.5678	3.1414	1.49136	32.2581	97.389	754.768
32	1024	32768	5.6569	3.1748	1.50515	31.2500	100.531	804.248
33	1089	35937	5.7446	3.2075	1.51851	30.3030	103.673	855.299
34	1156	39304	5.8310	3.2396	1.53148	29.4118	106.814	907.920
35	1225	42875	5.9161	3.2711	1.54407	28.5714	109.956	962.113
36	1296	46656	6.0000	3.3019	1.55630	27.7778	113.097	1017.88
37	1369	50653	6.0828	3.3322	1.56820	27.0270	116.239	1075.21
38	1444	54872	6.1644	3.3620	1.57978	26.3158	119.381	1134.11
39	1521	59319	6.2450	3.3912	1.59106	25.6410	122.522	1194.59
40	1600	64000	6.3246	3.4200	1.60206	25.0000	125.66	1256.64
41	1681	68921	6.4031	3.4482	1.61278	24.3902	128.81	1320.25
42	1764	74088	6.4807	3.4760	1.62325	23.8095	131.95	1385.44
43	1849	79507	6.5574	3.5034	1.63347	23.2558	135.09	1452.20
44	1936	85184	6.6332	3.5303	1.64345	22.7273	138.23	1520.53
45	2025	91125	6.7082	3.5569	1.65321	22.2222	141.37	1590.43
46	2116	97336	6.7823	3.5830	1.66276	21.7391	144.51	1661.90
47	2209	103823	6.8557	3.6088	1.67210	21.2766	147.65	1734.94
48	2304	110592	6.9282	3.6342	1.68124	20.8333	150.80	1809.56
49	2401	117649	7.0000	3.6593	1.69020	20.4082	153.94	1885.74

FUNCTIONS OF NUMBERS

50
99

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
50	2500	125000	7.0711	3.6840	1.69897	20.0000	157.08	1963.50
51	2601	132651	7.1414	3.7084	1.70757	19.6078	160.22	2042.82
52	2704	140608	7.2111	3.7325	1.71600	19.2308	163.36	2123.72
53	2809	148877	7.2801	3.7563	1.72428	18.8679	166.50	2206.18
54	2916	157464	7.3485	3.7798	1.73239	18.5185	169.65	2290.22
55	3025	166375	7.4162	3.8030	1.74036	18.1818	172.79	2375.83
56	3136	175616	7.4833	3.8259	1.74819	17.8571	175.93	2463.01
57	3249	185193	7.5498	3.8485	1.75587	17.5439	179.07	2551.76
58	3364	195112	7.6158	3.8709	1.76343	17.2414	182.21	2642.08
59	3481	205379	7.6811	3.8930	1.77085	16.9492	185.35	2733.97
60	3600	216000	7.7460	3.9149	1.77815	16.6667	188.50	2827.43
61	3721	226981	7.8102	3.9365	1.78533	16.3934	191.64	2922.47
62	3844	238328	7.8740	3.9579	1.79239	16.1290	194.78	3019.07
63	3969	250047	7.9373	3.9791	1.79934	15.8730	197.92	3117.25
64	4096	262144	8.0000	4.0000	1.80618	15.6250	201.06	3216.99
65	4225	274625	8.0623	4.0207	1.81291	15.3846	204.20	3318.31
66	4356	287496	8.1240	4.0412	1.81954	15.1515	207.35	3421.19
67	4489	300763	8.1854	4.0615	1.82607	14.9254	210.49	3525.65
68	4624	314432	8.2462	4.0817	1.83251	14.7059	213.63	3631.68
69	4761	328509	8.3066	4.1016	1.83885	14.4928	216.77	3739.28
70	4900	343000	8.3666	4.1213	1.84510	14.2857	219.91	3848.45
71	5041	357911	8.4261	4.1408	1.85126	14.0845	223.05	3959.19
72	5184	373248	8.4853	4.1602	1.85733	13.8889	226.19	4071.50
73	5329	389017	8.5440	4.1793	1.86332	13.6986	229.34	4185.39
74	5476	405224	8.6023	4.1983	1.86923	13.5135	232.48	4300.84
75	5625	421875	8.6603	4.2172	1.87506	13.3333	235.62	4417.86
76	5776	438976	8.7178	4.2358	1.88081	13.1579	238.76	4536.46
77	5929	456533	8.7750	4.2543	1.88649	12.9870	241.90	4656.63
78	6084	474552	8.8318	4.2727	1.89209	12.8205	245.04	4778.36
79	6241	493039	8.8882	4.2908	1.89763	12.6582	248.19	4901.67
80	6400	512000	8.9443	4.3089	1.90309	12.5000	251.33	5026.55
81	6561	531441	9.0000	4.3267	1.90849	12.3457	254.47	5153.00
82	6724	551368	9.0554	4.3445	1.91381	12.1951	257.61	5281.02
83	6889	571787	9.1104	4.3621	1.91908	12.0482	260.75	5410.61
84	7056	592704	9.1652	4.3795	1.92428	11.9048	263.89	5541.77
85	7225	614125	9.2195	4.3968	1.92942	11.7647	267.04	5674.50
86	7396	636056	9.2736	4.4140	1.93450	11.6279	270.18	5808.80
87	7569	658503	9.3274	4.4310	1.93952	11.4943	273.32	5944.68
88	7744	681472	9.3808	4.4480	1.94448	11.3636	276.46	6082.12
89	7921	704969	9.4340	4.4647	1.94939	11.2360	279.60	6221.14
90	8100	729000	9.4868	4.4814	1.95424	11.1111	282.74	6361.73
91	8281	753571	9.5394	4.4979	1.95904	10.9890	285.88	6503.88
92	8464	778688	9.5917	4.5144	1.96379	10.8696	289.03	6647.61
93	8649	804357	9.6437	4.5307	1.96848	10.7527	292.17	6792.91
94	8836	830584	9.6954	4.5468	1.97313	10.6383	295.31	6939.78
95	9025	857375	9.7468	4.5629	1.97772	10.5263	298.45	7088.22
96	9216	884736	9.7980	4.5789	1.98227	10.4167	301.59	7238.23
97	9409	912673	9.8489	4.5947	1.98677	10.3093	304.73	7389.81
98	9604	941192	9.8995	4.6104	1.99123	10.2041	307.88	7542.96
99	9801	970299	9.9499	4.6261	1.99564	10.1010	311.02	7697.69

100
149

FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
100	10000	1000000	10.0000	4.6416	2.00000	10.0000	314.16	7853.98
101	10201	1030301	10.0499	4.6570	2.00432	9.90099	317.30	8011.85
102	10404	1061208	10.0995	4.6723	2.00860	9.80392	320.44	8171.28
103	10609	1092727	10.1489	4.6875	2.01284	9.70874	323.58	8332.29
104	10816	1124864	10.1980	4.7027	2.01703	9.61538	326.73	8494.87
105	11025	1157625	10.2470	4.7177	2.02119	9.52381	329.87	8659.01
106	11236	1191016	10.2956	4.7326	2.02531	9.43396	333.01	8824.73
107	11449	1225043	10.3441	4.7475	2.02938	9.34579	336.15	8992.02
108	11664	1259712	10.3923	4.7622	2.03342	9.25926	339.29	9160.88
109	11881	1295029	10.4403	4.7769	2.03743	9.17431	342.43	9331.32
110	12100	1331000	10.4881	4.7914	2.04139	9.09091	345.58	9503.32
111	12321	1367631	10.5357	4.8059	2.04532	9.00901	348.72	9676.89
112	12544	1404928	10.5830	4.8203	2.04922	8.92857	351.86	9852.03
113	12769	1442897	10.6301	4.8346	2.05308	8.84956	355.00	10028.7
114	12996	1481544	10.6771	4.8488	2.05690	8.77193	358.14	10207.0
115	13225	1520875	10.7238	4.8629	2.06070	8.69565	361.28	10386.9
116	13456	1560896	10.7703	4.8770	2.06446	8.62069	364.42	10568.3
117	13689	1601613	10.8167	4.8910	2.06819	8.54701	367.57	10751.3
118	13924	1643032	10.8628	4.9049	2.07188	8.47458	370.71	10935.9
119	14161	1685159	10.9087	4.9187	2.07555	8.40336	373.85	11122.0
120	14400	1728000	10.9545	4.9324	2.07918	8.33333	376.99	11309.7
121	14641	1771561	11.0000	4.9461	2.08279	8.26446	380.13	11499.0
122	14884	1815848	11.0454	4.9597	2.08636	8.19672	383.27	11689.9
123	15129	1860867	11.0905	4.9732	2.08991	8.13008	386.42	11882.3
124	15376	1906624	11.1355	4.9866	2.09342	8.06452	389.56	12076.3
125	15625	1953125	11.1803	5.0000	2.09691	8.00000	392.70	12271.8
126	15876	2000376	11.2250	5.0133	2.10037	7.93651	395.84	12469.0
127	16129	2048383	11.2694	5.0265	2.10380	7.87402	398.98	12667.7
128	16384	2097152	11.3137	5.0397	2.10721	7.81250	402.12	12868.0
129	16641	2146689	11.3578	5.0528	2.11059	7.75194	405.27	13069.8
130	16900	2197000	11.4018	5.0658	2.11394	7.69231	408.41	13273.2
131	17161	2248091	11.4455	5.0788	2.11727	7.63359	411.55	13478.2
132	17424	2299968	11.4891	5.0916	2.12057	7.57576	414.69	13684.8
133	17689	2352637	11.5326	5.1045	2.12385	7.51880	417.83	13892.9
134	17956	2406104	11.5758	5.1172	2.12710	7.46269	420.97	14102.6
135	18225	2460375	11.6190	5.1299	2.13033	7.40741	424.12	14313.9
136	18496	2515456	11.6619	5.1426	2.13354	7.35294	427.26	14526.7
137	18769	2571353	11.7047	5.1551	2.13672	7.29927	430.40	14741.1
138	19044	2628072	11.7473	5.1676	2.13988	7.24638	433.54	14957.1
139	19321	2685619	11.7898	5.1801	2.14301	7.19424	436.68	15174.7
140	19600	2744000	11.8322	5.1925	2.14613	7.14286	439.82	15393.8
141	19881	2803221	11.8743	5.2048	2.14922	7.09220	442.96	15614.5
142	20164	2863288	11.9164	5.2171	2.15229	7.04225	446.11	15836.8
143	20449	2924207	11.9583	5.2293	2.15534	6.99301	449.25	16060.6
144	20736	2985984	12.0000	5.2415	2.15836	6.94444	452.39	16286.0
145	21025	3048625	12.0416	5.2536	2.16137	6.89655	455.53	16513.0
146	21316	3112136	12.0830	5.2656	2.16435	6.84932	458.67	16741.5
147	21609	3176523	12.1244	5.2776	2.16732	6.80272	461.81	16971.7
148	21904	3241792	12.1655	5.2896	2.17026	6.75676	464.96	17203.4
149	22201	3307949	12.2066	5.3015	2.17319	6.71141	468.10	17436.6

FUNCTIONS OF NUMBERS

150
199

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	Area
150	22500	3375000	12.2474	5.3133	2.17609	6.66667	471.24	17671.5
151	22801	3442951	12.2882	5.3251	2.17898	6.62252	474.38	17907.9
152	23104	3511808	12.3288	5.3368	2.18184	6.57895	477.52	18145.8
153	23409	3581577	12.3693	5.3485	2.18469	6.53595	480.66	18385.4
154	23716	3652264	12.4097	5.3601	2.18752	6.49351	483.81	18626.5
155	24025	3723875	12.4499	5.3717	2.19033	6.45161	486.95	18869.2
156	24336	3796416	12.4900	5.3832	2.19312	6.41026	490.09	19113.4
157	24649	3869893	12.5300	5.3947	2.19590	6.36943	493.23	19359.3
158	24964	3944312	12.5698	5.4061	2.19866	6.32911	496.37	19606.7
159	25281	4019679	12.6095	5.4175	2.20140	6.28931	499.51	19855.7
160	25600	4096000	12.6491	5.4288	2.20412	6.25000	502.65	20106.2
161	25921	4173281	12.6886	5.4401	2.20683	6.21118	505.80	20358.3
162	26244	4251528	12.7279	5.4514	2.20952	6.17284	508.94	20612.0
163	26569	4330747	12.7671	5.4626	2.21219	6.13497	512.08	20867.2
164	26896	4410944	12.8062	5.4737	2.21484	6.09756	515.22	21124.1
165	27225	4492125	12.8452	5.4848	2.21748	6.06061	518.36	21382.5
166	27556	4574296	12.8841	5.4959	2.22011	6.02410	521.50	21642.4
167	27889	4657463	12.9228	5.5069	2.22272	5.98802	524.65	21904.0
168	28224	4741632	12.9615	5.5178	2.22531	5.95238	527.79	22167.1
169	28561	4826809	13.0000	5.5288	2.22789	5.91716	530.93	22431.8
170	28900	4913000	13.0384	5.5397	2.23045	5.88235	534.07	22698.0
171	29241	5000211	13.0767	5.5505	2.23300	5.84795	537.21	22965.8
172	29584	5088448	13.1149	5.5613	2.23553	5.81395	540.35	23235.2
173	29929	5177717	13.1529	5.5721	2.23805	5.78035	543.50	23506.2
174	30276	5268024	13.1909	5.5828	2.24055	5.74713	546.64	23778.7
175	30625	5359375	13.2288	5.5934	2.24304	5.71429	549.78	24052.8
176	30976	5451776	13.2665	5.6041	2.24551	5.68182	552.92	24328.5
177	31329	5545233	13.3041	5.6147	2.24797	5.64972	556.06	24605.7
178	31684	5639752	13.3417	5.6252	2.25042	5.61798	559.20	24884.6
179	32041	5735339	13.3791	5.6357	2.25285	5.58659	562.35	25164.9
180	32400	5832000	13.4164	5.6462	2.25527	5.55556	565.49	25446.9
181	32761	5929741	13.4536	5.6567	2.25768	5.52486	568.63	25730.4
182	33124	6028568	13.4907	5.6671	2.26007	5.49451	571.77	26015.5
183	33489	6128487	13.5277	5.6774	2.26245	5.46448	574.91	26302.2
184	33856	6229504	13.5647	5.6877	2.26482	5.43478	578.05	26590.4
185	34225	6331625	13.6015	5.6980	2.26717	5.40541	581.19	26880.3
186	34596	6434856	13.6382	5.7083	2.26951	5.37634	584.34	27171.6
187	34969	6539203	13.6748	5.7185	2.27184	5.34759	587.48	27464.6
188	35344	6644672	13.7113	5.7287	2.27416	5.31915	590.62	27759.1
189	35721	6751269	13.7477	5.7388	2.27646	5.29101	593.76	28055.2
190	36100	6859000	13.7840	5.7489	2.27875	5.26316	596.90	28352.9
191	36481	6967871	13.8203	5.7590	2.28103	5.23560	600.04	28652.1
192	36864	7077888	13.8564	5.7690	2.28330	5.20833	603.19	28952.9
193	37249	7189057	13.8924	5.7790	2.28556	5.18135	606.33	29255.3
194	37636	7301384	13.9284	5.7890	2.28780	5.15464	609.47	29559.2
195	38025	7414875	13.9642	5.7989	2.29003	5.12821	612.61	29864.8
196	38416	7529536	14.0000	5.8088	2.29226	5.10204	615.75	30171.9
197	38809	7645373	14.0357	5.8186	2.29447	5.07614	618.89	30480.5
198	39204	7762392	14.0712	5.8285	2.29667	5.05051	622.04	30790.7
199	39601	7880599	14.1067	5.8383	2.29885	5.02513	625.18	31102.6

200
249

FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
200	40000	8000000	14.1421	5.8480	2.30103	5.00000	628.32	31415.9
201	40401	8120601	14.1774	5.8578	2.30320	4.97512	631.46	31730.9
202	40804	8242408	14.2127	5.8675	2.30535	4.95050	634.60	32047.4
203	41209	8365427	14.2478	5.8771	2.30750	4.92611	637.74	32365.5
204	41616	8489664	14.2829	5.8868	2.30963	4.90196	640.88	32685.1
205	42025	8615125	14.3178	5.8964	2.31175	4.87805	644.03	33006.4
206	42436	8741816	14.3527	5.9059	2.31387	4.85437	647.17	33329.2
207	42849	8869743	14.3875	5.9155	2.31597	4.83092	650.31	33653.5
208	43264	8998912	14.4222	5.9250	2.31806	4.80769	653.45	33979.5
209	43681	9129329	14.4568	5.9345	2.32015	4.78469	656.59	34307.0
210	44100	9261000	14.4914	5.9439	2.32222	4.76190	659.73	34636.1
211	44521	9393931	14.5258	5.9533	2.32428	4.73934	662.88	34966.7
212	44944	9528128	14.5602	5.9627	2.32634	4.71698	666.02	35298.9
213	45369	9663597	14.5945	5.9721	2.32838	4.69484	669.16	35632.7
214	45796	9800344	14.6287	5.9814	2.33041	4.67290	672.30	35968.1
215	46225	9938375	14.6629	5.9907	2.33244	4.65116	675.44	36305.0
216	46656	10077696	14.6969	6.0000	2.33445	4.62963	678.58	36643.5
217	47089	10218313	14.7309	6.0092	2.33646	4.60829	681.73	36983.6
218	47524	10360232	14.7648	6.0185	2.33846	4.58716	684.87	37325.3
219	47961	10503459	14.7986	6.0277	2.34044	4.56621	688.01	37668.5
220	48400	10648000	14.8324	6.0368	2.34242	4.54545	691.15	38013.3
221	48841	10793861	14.8661	6.0459	2.34439	4.52489	694.29	38359.6
222	49284	10941048	14.8997	6.0550	2.34635	4.50450	697.43	38707.6
223	49729	11089567	14.9332	6.0641	2.34830	4.48430	700.58	39057.1
224	50176	11239424	14.9666	6.0732	2.35025	4.46429	703.72	39408.1
225	50625	11390625	15.0000	6.0822	2.35218	4.44444	706.86	39760.8
226	51076	11543176	15.0333	6.0912	2.35411	4.42478	710.00	40115.0
227	51529	11697083	15.0665	6.1002	2.35603	4.40529	713.14	40470.8
228	51984	11852352	15.0997	6.1091	2.35793	4.38596	716.28	40828.1
229	52441	12008989	15.1327	6.1180	2.35984	4.36681	719.42	41187.1
230	52900	12167000	15.1658	6.1269	2.36173	4.34783	722.57	41547.6
231	53361	12326391	15.1987	6.1358	2.36361	4.32900	725.71	41909.6
232	53824	12487168	15.2315	6.1446	2.36549	4.31034	728.85	42273.3
233	54289	12649337	15.2643	6.1534	2.36736	4.29185	731.99	42638.5
234	54756	12812904	15.2971	6.1622	2.36922	4.27350	735.13	43005.3
235	55225	12977875	15.3297	6.1710	2.37107	4.25532	738.27	43373.6
236	55696	13144256	15.3623	6.1797	2.37291	4.23729	741.42	43743.5
237	56169	13312053	15.3948	6.1885	2.37475	4.21941	744.56	44115.0
238	56644	13481272	15.4272	6.1972	2.37658	4.20168	747.70	44488.1
239	57121	13651919	15.4596	6.2058	2.37840	4.18410	750.84	44862.7
240	57600	13824000	15.4919	6.2145	2.38021	4.16667	753.98	45238.9
241	58081	13997521	15.5242	6.2231	2.38202	4.14938	757.12	45616.7
242	58564	14172488	15.5563	6.2317	2.38382	4.13223	760.27	45996.1
243	59049	14348907	15.5885	6.2403	2.38561	4.11523	763.41	46377.0
244	59536	14526784	15.6205	6.2488	2.38739	4.09836	766.55	46759.5
245	60025	14706125	15.6525	6.2573	2.38917	4.08163	769.69	47143.5
246	60516	14886936	15.6844	6.2658	2.39094	4.06504	772.83	47529.2
247	61009	15069223	15.7162	6.2743	2.39270	4.04858	775.97	47916.4
248	61504	15252992	15.7480	6.2828	2.39445	4.03226	779.11	48305.1
249	62001	15438249	15.7797	6.2912	2.39620	4.01606	782.26	48695.5

FUNCTIONS OF NUMBERS

250
299

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
250	62500	15625000	15.8114	6.2996	2.39794	4.00000	785.40	49087.4
251	63001	15813251	15.8430	6.3080	2.39967	3.98406	788.54	49480.9
252	63504	16003008	15.8745	6.3164	2.40140	3.96825	791.68	49875.9
253	64009	16194277	15.9060	6.3247	2.40312	3.95257	794.82	50272.6
254	64516	16387064	15.9374	6.3330	2.40483	3.93701	797.96	50670.7
255	65025	16581375	15.9687	6.3413	2.40654	3.92157	801.11	51070.5
256	65536	16777216	16.0000	6.3496	2.40824	3.90625	804.25	51471.9
257	66049	16974593	16.0312	6.3579	2.40993	3.89105	807.39	51874.8
258	66564	17173512	16.0624	6.3661	2.41162	3.87597	810.53	52279.2
259	67081	17373979	16.0935	6.3743	2.41330	3.86100	813.67	52685.3
260	67600	17576000	16.1245	6.3825	2.41497	3.84615	816.81	53092.9
261	68121	17779581	16.1555	6.3907	2.41664	3.83142	819.96	53502.1
262	68644	17984728	16.1864	6.3988	2.41830	3.81679	823.10	53912.9
263	69169	18191447	16.2173	6.4070	2.41996	3.80228	826.24	54325.2
264	69696	18399744	16.2481	6.4151	2.42160	3.78788	829.38	54739.1
265	70225	18609625	16.2788	6.4232	2.42325	3.77358	832.52	55154.6
266	70756	18821096	16.3095	6.4312	2.42488	3.75940	835.66	55571.6
267	71289	19034163	16.3401	6.4393	2.42651	3.74532	838.81	55990.2
268	71824	19248832	16.3707	6.4473	2.42813	3.73134	841.95	56410.4
269	72361	19465109	16.4012	6.4553	2.42975	3.71747	845.09	56832.2
270	72900	19683000	16.4317	6.4633	2.43136	3.70370	848.23	57255.5
271	73441	19902511	16.4621	6.4713	2.43297	3.69004	851.37	57680.4
272	73984	20123648	16.4924	6.4792	2.43457	3.67647	854.51	58106.9
273	74529	20346417	16.5227	6.4872	2.43616	3.66300	857.65	58534.9
274	75076	20570824	16.5529	6.4951	2.43775	3.64964	860.80	58964.6
275	75625	20796875	16.5831	6.5030	2.43933	3.63636	863.94	59395.7
276	76176	21024576	16.6132	6.5108	2.44091	3.62319	867.08	59828.5
277	76729	21253933	16.6433	6.5187	2.44248	3.61011	870.22	60262.8
278	77284	21484952	16.6733	6.5265	2.44404	3.59712	873.36	60698.7
279	77841	21717639	16.7033	6.5343	2.44560	3.58423	876.50	61136.2
280	78400	21952000	16.7332	6.5421	2.44716	3.57143	879.65	61575.2
281	78961	22188041	16.7631	6.5499	2.44871	3.55872	882.79	62015.8
282	79524	22425768	16.7929	6.5577	2.45025	3.54610	885.93	62458.0
283	80089	22665187	16.8226	6.5654	2.45179	3.53357	889.07	62901.8
284	80656	22906304	16.8523	6.5731	2.45332	3.52113	892.21	63347.1
285	81225	23149125	16.8819	6.5808	2.45484	3.50877	895.35	63794.0
286	81796	23393656	16.9115	6.5885	2.45637	3.49650	898.50	64242.4
287	82369	23639903	16.9411	6.5962	2.45788	3.48432	901.64	64692.5
288	82944	23887872	16.9706	6.6039	2.45939	3.47222	904.78	65144.1
289	83521	24137569	17.0000	6.6115	2.46090	3.46021	907.92	65597.2
290	84100	24389000	17.0294	6.6191	2.46240	3.44828	911.06	66052.0
291	84681	24642171	17.0587	6.6267	2.46389	3.43643	914.20	66508.3
292	85264	24897088	17.0880	6.6343	2.46538	3.42466	917.35	66966.2
293	85849	25153757	17.1172	6.6419	2.46687	3.41297	920.49	67425.6
294	86436	25412184	17.1464	6.6494	2.46835	3.40136	923.63	67886.7
295	87025	25672375	17.1756	6.6569	2.46982	3.38983	926.77	68349.3
296	87616	25934336	17.2047	6.6644	2.47129	3.37838	929.91	68813.4
297	88209	26198073	17.2337	6.6719	2.47276	3.36700	933.05	69279.2
298	88804	26463592	17.2627	6.6794	2.47422	3.35570	936.19	69746.5
299	89401	26730899	17.2916	6.6869	2.47567	3.34448	939.34	70215.4

300
349

FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
300	90000	27000000	17.3205	6.6943	2.47712	3.33333	942.48	70685.8
301	90601	27270901	17.3494	6.7018	2.47857	3.32226	945.62	71157.9
302	91204	27543608	17.3781	6.7092	2.48001	3.31126	948.76	71631.5
303	91809	27818127	17.4069	6.7166	2.48144	3.30033	951.90	72106.6
304	92416	28094464	17.4356	6.7240	2.48287	3.28947	955.04	72583.4
305	93025	28372625	17.4642	6.7313	2.48430	3.27869	958.19	73061.7
306	93636	28652616	17.4929	6.7387	2.48572	3.26797	961.33	73541.5
307	94249	28934443	17.5214	6.7460	2.48714	3.25733	964.47	74023.0
308	94864	29218112	17.5499	6.7533	2.48855	3.24675	967.61	74506.0
309	95481	29503629	17.5784	6.7606	2.48996	3.23625	970.75	74990.6
310	96100	29791000	17.6068	6.7679	2.49136	3.22581	973.89	75476.8
311	96721	30080231	17.6352	6.7752	2.49276	3.21543	977.04	75964.5
312	97344	30371328	17.6635	6.7824	2.49415	3.20513	980.18	76453.8
313	97969	30664297	17.6918	6.7897	2.49554	3.19489	983.32	76944.7
314	98596	30959144	17.7200	6.7969	2.49693	3.18471	986.46	77437.1
315	99225	31255875	17.7482	6.8041	2.49831	3.17460	989.60	77931.1
316	99856	31554496	17.7764	6.8113	2.49969	3.16456	992.74	78426.7
317	100489	31855013	17.8045	6.8185	2.50106	3.15457	995.88	78923.9
318	101124	32157432	17.8326	6.8256	2.50243	3.14465	999.03	79422.6
319	101761	32461759	17.8606	6.8328	2.50379	3.13480	1002.2	79922.9
320	102400	32768000	17.8885	6.8399	2.50515	3.12500	1005.3	80424.8
321	103041	33076161	17.9165	6.8470	2.50651	3.11526	1008.5	80928.2
322	103684	33386248	17.9444	6.8541	2.50786	3.10559	1011.6	81433.2
323	104329	33698267	17.9722	6.8612	2.50920	3.09598	1014.7	81939.8
324	104976	34012224	18.0000	6.8683	2.51055	3.08642	1017.9	82448.0
325	105625	34328125	18.0278	6.8753	2.51188	3.07692	1021.0	82957.7
326	106276	34645976	18.0555	6.8824	2.51322	3.06749	1024.2	83469.0
327	106929	34965783	18.0831	6.8894	2.51455	3.05810	1027.3	83981.8
328	107584	35287552	18.1108	6.8964	2.51587	3.04878	1030.4	84496.3
329	108241	35611289	18.1384	6.9034	2.51720	3.03951	1033.6	85012.3
330	108900	35937000	18.1659	6.9104	2.51851	3.03030	1036.7	85529.9
331	109561	36264691	18.1934	6.9174	2.51983	3.02115	1039.9	86049.0
332	110224	36594368	18.2209	6.9244	2.52114	3.01205	1043.0	86569.7
333	110889	36926037	18.2483	6.9313	2.52244	3.00300	1046.2	87092.0
334	111556	37259704	18.2757	6.9382	2.52375	2.99401	1049.3	87615.9
335	112225	37595375	18.3030	6.9451	2.52504	2.98507	1052.4	88141.3
336	112896	37933056	18.3303	6.9521	2.52634	2.97619	1055.6	88668.3
337	113569	38272753	18.3576	6.9589	2.52763	2.96736	1058.7	89196.9
338	114244	38614472	18.3848	6.9658	2.52892	2.95858	1061.9	89727.0
339	114921	38958219	18.4120	6.9727	2.53020	2.94985	1065.0	90258.7
340	115600	39304000	18.4391	6.9795	2.53148	2.94118	1068.1	90792.0
341	116281	39651821	18.4662	6.9864	2.53275	2.93255	1071.3	91326.9
342	116964	40001688	18.4932	6.9932	2.53403	2.92398	1074.4	91863.3
343	117649	40353607	18.5203	7.0000	2.53529	2.91545	1077.6	92401.3
344	118336	40707584	18.5472	7.0068	2.53656	2.90698	1080.7	92940.9
345	119025	41063625	18.5742	7.0136	2.53782	2.89855	1083.8	93482.0
346	119716	41421736	18.6011	7.0203	2.53908	2.89017	1087.0	94024.7
347	120409	41781923	18.6279	7.0271	2.54033	2.88184	1090.1	94569.0
348	121104	42144192	18.6548	7.0338	2.54158	2.87356	1093.3	95114.9
349	121801	42508549	18.6815	7.0406	2.54283	2.86533	1096.4	95662.3

FUNCTIONS OF NUMBERS

350
399

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	Area
350	122500	42875000	18.7083	7.0473	2.54407	2.85714	1099.6	96211.3
351	123201	43243551	18.7350	7.0540	2.54531	2.84900	1102.7	96761.8
352	123904	43614208	18.7617	7.0607	2.54654	2.84091	1105.8	97314.0
353	124609	43986977	18.7883	7.0674	2.54777	2.83286	1109.0	97867.7
354	125316	44361864	18.8149	7.0740	2.54900	2.82486	1112.1	98423.0
355	126025	44738875	18.8414	7.0807	2.55023	2.81690	1115.3	98979.8
356	126736	45118016	18.8680	7.0873	2.55145	2.80899	1118.4	99538.2
357	127449	45499293	18.8944	7.0940	2.55267	2.80112	1121.5	100098
358	128164	45882712	18.9209	7.1006	2.55388	2.79330	1124.7	100660
359	128881	46268279	18.9473	7.1072	2.55509	2.78552	1127.8	101223
360	129600	46656000	18.9737	7.1138	2.55630	2.77778	1131.0	101788
361	130321	47045881	19.0000	7.1204	2.55751	2.77008	1134.1	102354
362	131044	47437928	19.0263	7.1269	2.55871	2.76243	1137.3	102922
363	131769	47832147	19.0526	7.1335	2.55991	2.75482	1140.4	103491
364	132496	48228544	19.0788	7.1400	2.56110	2.74725	1143.5	104062
365	133225	48627125	19.1050	7.1466	2.56229	2.73973	1146.7	104635
366	133956	49027896	19.1311	7.1531	2.56348	2.73224	1149.8	105209
367	134689	49430863	19.1572	7.1596	2.56467	2.72480	1153.0	105784
368	135424	49836032	19.1833	7.1661	2.56585	2.71739	1156.1	106362
369	136161	50243409	19.2094	7.1726	2.56703	2.71003	1159.2	106941
370	136900	50653000	19.2354	7.1791	2.56820	2.70270	1162.4	107521
371	137641	51064811	19.2614	7.1855	2.56937	2.69542	1165.5	108103
372	138384	51478848	19.2873	7.1920	2.57054	2.68817	1168.7	108687
373	139129	51895117	19.3132	7.1984	2.57171	2.68097	1171.8	109272
374	139876	52313624	19.3391	7.2048	2.57287	2.67380	1175.0	109858
375	140625	52734375	19.3649	7.2112	2.57403	2.66667	1178.1	110447
376	141376	53157376	19.3907	7.2177	2.57519	2.65957	1181.2	111036
377	142129	53582633	19.4165	7.2240	2.57634	2.65252	1184.4	111628
378	142884	54010152	19.4422	7.2304	2.57749	2.64550	1187.5	112221
379	143641	54439939	19.4679	7.2368	2.57864	2.63852	1190.7	112815
380	144400	54872000	19.4936	7.2432	2.57978	2.63158	1193.8	113411
381	145161	55306341	19.5192	7.2495	2.58093	2.62467	1196.9	114009
382	145924	55742968	19.5448	7.2558	2.58206	2.61780	1200.1	114608
383	146689	56181887	19.5704	7.2622	2.58320	2.61097	1203.2	115209
384	147456	56623104	19.5959	7.2685	2.58433	2.60417	1206.4	115812
385	148225	57066625	19.6214	7.2748	2.58546	2.59740	1209.5	116416
386	148996	57512456	19.6469	7.2811	2.58659	2.59067	1212.7	117021
387	149769	57960603	19.6723	7.2874	2.58771	2.58398	1215.8	117628
388	150544	58411072	19.6977	7.2936	2.58883	2.57732	1218.9	118237
389	151321	58863869	19.7231	7.2999	2.58995	2.57069	1222.1	118847
390	152100	59319000	19.7484	7.3061	2.59106	2.56410	1225.2	119459
391	152881	59776471	19.7737	7.3124	2.59218	2.55754	1228.4	120072
392	153664	60236288	19.7990	7.3186	2.59329	2.55102	1231.5	120687
393	154449	60698457	19.8242	7.3248	2.59439	2.54453	1234.6	121304
394	155236	61162984	19.8494	7.3310	2.59550	2.53807	1237.8	121922
395	156025	61629875	19.8746	7.3372	2.59660	2.53165	1240.9	122542
396	156816	62099136	19.8997	7.3434	2.59770	2.52525	1244.1	123163
397	157609	62570773	19.9249	7.3496	2.59879	2.51889	1247.2	123786
398	158404	63044792	19.9499	7.3558	2.59988	2.51256	1250.4	124410
399	159201	63521199	19.9750	7.3619	2.60097	2.50627	1253.5	125036

400
449

FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	Area
400	160000	64000000	20.0000	7.3681	2.60206	2.50000	1256.6	125664
401	160801	64481201	20.0250	7.3742	2.60314	2.49377	1259.8	126293
402	161604	64964808	20.0499	7.3803	2.60423	2.48756	1262.9	126923
403	162409	65450827	20.0749	7.3864	2.60531	2.48139	1266.1	127556
404	163216	65939264	20.0998	7.3925	2.60638	2.47525	1269.2	128190
405	164025	66430125	20.1246	7.3986	2.60746	2.46914	1272.3	128825
406	164836	66923416	20.1494	7.4047	2.60853	2.46305	1275.5	129462
407	165649	67419143	20.1742	7.4108	2.60959	2.45700	1278.6	130100
408	166464	67917312	20.1990	7.4169	2.61066	2.45098	1281.8	130741
409	167281	68417929	20.2237	7.4229	2.61172	2.44499	1284.9	131382
410	168100	68921000	20.2485	7.4290	2.61278	2.43902	1288.1	132025
411	168921	69426531	20.2731	7.4350	2.61384	2.43309	1291.2	132670
412	169744	69934528	20.2978	7.4410	2.61490	2.42718	1294.3	133317
413	170569	70444997	20.3224	7.4470	2.61595	2.42131	1297.5	133965
414	171396	70957944	20.3470	7.4530	2.61700	2.41546	1300.6	134614
415	172225	71473375	20.3715	7.4590	2.61805	2.40964	1303.8	135265
416	173056	71991296	20.3961	7.4650	2.61909	2.40385	1306.9	135918
417	173889	72511713	20.4206	7.4710	2.62014	2.39808	1310.0	136572
418	174724	73034632	20.4450	7.4770	2.62118	2.39234	1313.2	137228
419	175561	73560059	20.4695	7.4829	2.62221	2.38663	1316.3	137885
420	176400	74088000	20.4939	7.4889	2.62325	2.38095	1319.5	138544
421	177241	74618461	20.5183	7.4948	2.62428	2.37530	1322.6	139205
422	178084	75151448	20.5426	7.5007	2.62531	2.36967	1325.8	139867
423	178929	75686967	20.5670	7.5067	2.62634	2.36407	1328.9	140531
424	179776	76225024	20.5913	7.5126	2.62737	2.35849	1332.0	141196
425	180625	76765625	20.6155	7.5185	2.62839	2.35294	1335.2	141863
426	181476	77308776	20.6398	7.5244	2.62941	2.34742	1338.3	142531
427	182329	77854483	20.6640	7.5302	2.63043	2.34192	1341.5	143201
428	183184	78402752	20.6882	7.5361	2.63144	2.33645	1344.6	143872
429	184041	78953589	20.7123	7.5420	2.63246	2.33100	1347.7	144545
430	184900	79507000	20.7364	7.5478	2.63347	2.32558	1350.9	145220
431	185761	80062991	20.7605	7.5537	2.63448	2.32019	1354.0	145896
432	186624	80621568	20.7846	7.5595	2.63548	2.31481	1357.2	146574
433	187489	81182737	20.8087	7.5654	2.63649	2.30947	1360.3	147254
434	188356	81746504	20.8327	7.5712	2.63749	2.30415	1363.5	147934
435	189225	82312875	20.8567	7.5770	2.63849	2.29885	1366.6	148617
436	190096	82881856	20.8806	7.5828	2.63949	2.29358	1369.7	149301
437	190969	83453453	20.9045	7.5886	2.64048	2.28833	1372.9	149987
438	191844	84027672	20.9284	7.5944	2.64147	2.28311	1376.0	150674
439	192721	84604519	20.9523	7.6001	2.64246	2.27790	1379.2	151363
440	193600	85184000	20.9762	7.6059	2.64345	2.27273	1382.3	152053
441	194481	85766121	21.0000	7.6117	2.64444	2.26757	1385.4	152745
442	195364	86350888	21.0238	7.6174	2.64542	2.26244	1388.6	153439
443	196249	86938307	21.0476	7.6232	2.64640	2.25734	1391.7	154134
444	197136	87528384	21.0713	7.6289	2.64738	2.25225	1394.9	154830
445	198025	88121125	21.0950	7.6346	2.64836	2.24719	1398.0	155528
446	198916	88716536	21.1187	7.6403	2.64933	2.24215	1401.2	156228
447	199809	89314623	21.1424	7.6460	2.65031	2.23714	1404.3	156930
448	200704	89915392	21.1660	7.6517	2.65128	2.23214	1407.4	157633
449	201601	90518849	21.1896	7.6574	2.65225	2.22717	1410.6	158337

FUNCTIONS OF NUMBERS

450
499

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
450	202500	91125000	21.2132	7.6631	2.65321	2.22222	1413.7	159043
451	203401	91733851	21.2368	7.6688	2.65418	2.21729	1416.9	159751
452	204304	92345408	21.2603	7.6744	2.65514	2.21239	1420.0	160460
453	205209	92959677	21.2838	7.6801	2.65610	2.20751	1423.1	161171
454	206116	93576664	21.3073	7.6857	2.65706	2.20264	1426.3	161883
455	207025	94196375	21.3307	7.6914	2.65801	2.19780	1429.4	162597
456	207936	94818816	21.3542	7.6970	2.65896	2.19298	1432.6	163313
457	208849	95443993	21.3776	7.7026	2.65992	2.18818	1435.7	164030
458	209764	96071912	21.4009	7.7082	2.66087	2.18341	1438.8	164748
459	210681	96702579	21.4243	7.7138	2.66181	2.17865	1442.0	165468
460	211600	97336000	21.4476	7.7194	2.66276	2.17391	1445.1	166190
461	212521	97972181	21.4709	7.7250	2.66370	2.16920	1448.3	166914
462	213444	98611128	21.4942	7.7306	2.66464	2.16450	1451.4	167639
463	214369	99252847	21.5174	7.7362	2.66558	2.15983	1454.6	168365
464	215296	99897344	21.5407	7.7418	2.66652	2.15517	1457.7	169093
465	216225	100544625	21.5639	7.7473	2.66745	2.15054	1460.8	169823
466	217156	101194696	21.5870	7.7529	2.66839	2.14592	1464.0	170554
467	218089	101847563	21.6102	7.7584	2.66932	2.14133	1467.1	171287
468	219024	102503232	21.6333	7.7639	2.67025	2.13675	1470.3	172021
469	219961	103161709	21.6564	7.7695	2.67117	2.13220	1473.4	172757
470	220900	103823000	21.6795	7.7750	2.67210	2.12766	1476.5	173494
471	221841	104487111	21.7025	7.7805	2.67302	2.12314	1479.7	174234
472	222784	105154048	21.7256	7.7860	2.67394	2.11864	1482.8	174974
473	223729	105823817	21.7486	7.7915	2.67486	2.11416	1486.0	175716
474	224676	106496424	21.7715	7.7970	2.67578	2.10970	1489.1	176460
475	225625	107171875	21.7945	7.8025	2.67669	2.10526	1492.3	177205
476	226576	107850176	21.8174	7.8079	2.67761	2.10084	1495.4	177952
477	227529	108531333	21.8403	7.8134	2.67852	2.09644	1498.5	178701
478	228484	109215352	21.8632	7.8188	2.67943	2.09205	1501.7	179451
479	229441	109902239	21.8861	7.8243	2.68034	2.08768	1504.8	180203
480	230400	110592000	21.9089	7.8297	2.68124	2.08333	1508.0	180956
481	231361	111284641	21.9317	7.8352	2.68215	2.07900	1511.1	181711
482	232324	111980168	21.9545	7.8406	2.68305	2.07469	1514.2	182467
483	233289	112678587	21.9773	7.8460	2.68395	2.07039	1517.4	183225
484	234256	113379904	22.0000	7.8514	2.68485	2.06612	1520.5	183984
485	235225	114084125	22.0227	7.8568	2.68574	2.06186	1523.7	184745
486	236196	114791256	22.0454	7.8622	2.68664	2.05761	1526.8	185508
487	237169	115501303	22.0681	7.8676	2.68753	2.05339	1530.0	186272
488	238144	116214272	22.0907	7.8730	2.68842	2.04918	1533.1	187038
489	239121	116930169	22.1133	7.8784	2.68931	2.04499	1536.2	187805
490	240100	117649000	22.1359	7.8837	2.69020	2.04082	1539.4	188574
491	241081	118370771	22.1585	7.8891	2.69108	2.03666	1542.5	189345
492	242064	119095488	22.1811	7.8944	2.69197	2.03252	1545.7	190117
493	243049	119823157	22.2036	7.8998	2.69285	2.02840	1548.8	190890
494	244036	120553784	22.2261	7.9051	2.69373	2.02429	1551.9	191665
495	245025	121287375	22.2486	7.9105	2.69461	2.02020	1555.1	192442
496	246016	122023936	22.2711	7.9158	2.69548	2.01613	1558.2	193221
497	247009	122763473	22.2935	7.9211	2.69636	2.01207	1561.4	194000
498	248004	123505992	22.3159	7.9264	2.69723	2.00803	1564.5	194782
499	249001	124251499	22.3383	7.9317	2.69810	2.00401	1567.7	195565

500
549

FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
500	250000	125000000	22.3607	7.9370	2.69897	2.00000	1570.8	196350
501	251001	125751501	22.3830	7.9423	2.69984	1.99601	1573.9	197136
502	252004	126506008	22.4054	7.9476	2.70070	1.99203	1577.1	197923
503	253009	127263527	22.4277	7.9528	2.70157	1.98807	1580.2	198713
504	254016	128024064	22.4499	7.9581	2.70243	1.98413	1583.4	199504
505	255025	128787625	22.4722	7.9634	2.70329	1.98020	1586.5	200296
506	256036	129554216	22.4944	7.9686	2.70415	1.97628	1589.6	201090
507	257049	130323843	22.5167	7.9739	2.70501	1.97239	1592.8	201886
508	258064	131096512	22.5389	7.9791	2.70586	1.96850	1595.9	202683
509	259081	131872229	22.5610	7.9843	2.70672	1.96464	1599.1	203482
510	260100	132651000	22.5832	7.9896	2.70757	1.96078	1602.2	204282
511	261121	133432831	22.6053	7.9948	2.70842	1.95695	1605.4	205084
512	262144	134217728	22.6274	8.0000	2.70927	1.95312	1608.5	205887
513	263169	135005697	22.6495	8.0052	2.71012	1.94932	1611.6	206692
514	264196	135796744	22.6716	8.0104	2.71096	1.94553	1614.8	207499
515	265225	136590875	22.6936	8.0156	2.71181	1.94175	1617.9	208307
516	266256	137388096	22.7156	8.0208	2.71265	1.93798	1621.1	209117
517	267289	138188413	22.7376	8.0260	2.71349	1.93424	1624.2	209928
518	268324	138991832	22.7596	8.0311	2.71433	1.93050	1627.3	210741
519	269361	139798359	22.7816	8.0363	2.71517	1.92678	1630.5	211556
520	270400	140608000	22.8035	8.0415	2.71600	1.92308	1633.6	212372
521	271441	141420761	22.8254	8.0466	2.71684	1.91939	1636.8	213189
522	272484	142236648	22.8473	8.0517	2.71767	1.91571	1639.9	214008
523	273529	143055667	22.8692	8.0569	2.71850	1.91205	1643.1	214829
524	274576	143877824	22.8910	8.0620	2.71933	1.90840	1646.2	215651
525	275625	144703125	22.9129	8.0671	2.72016	1.90476	1649.3	216475
526	276676	145531576	22.9347	8.0723	2.72099	1.90114	1652.5	217301
527	277729	146363183	22.9565	8.0774	2.72181	1.89753	1655.6	218128
528	278784	147197952	22.9783	8.0825	2.72263	1.89394	1658.8	218956
529	279841	148035889	23.0000	8.0876	2.72346	1.89036	1661.9	219787
530	280900	148877000	23.0217	8.0927	2.72428	1.88679	1665.0	220618
531	281961	149721291	23.0434	8.0978	2.72509	1.88324	1668.2	221452
532	283024	150568768	23.0651	8.1028	2.72591	1.87970	1671.3	222287
533	284089	151419437	23.0868	8.1079	2.72673	1.87617	1674.5	223123
534	285156	152273304	23.1084	8.1130	2.72754	1.87266	1677.6	223961
535	286225	153130375	23.1301	8.1180	2.72835	1.86916	1680.8	224801
536	287296	153990656	23.1517	8.1231	2.72916	1.86567	1683.9	225642
537	288369	154854153	23.1733	8.1281	2.72997	1.86220	1687.0	226484
538	289444	155720872	23.1948	8.1332	2.73078	1.85874	1690.2	227329
539	290521	156590819	23.2164	8.1382	2.73159	1.85529	1693.3	228175
540	291600	157464000	23.2379	8.1433	2.73239	1.85185	1696.5	229022
541	292681	158340421	23.2594	8.1483	2.73320	1.84843	1699.6	229871
542	293764	159220088	23.2809	8.1533	2.73400	1.84502	1702.7	230722
543	294849	160103007	23.3024	8.1583	2.73480	1.84162	1705.9	231574
544	295936	160989184	23.3238	8.1633	2.73560	1.83824	1709.0	232428
545	297025	161878625	23.3452	8.1683	2.73640	1.83486	1712.2	233283
546	298116	162771336	23.3666	8.1733	2.73719	1.83150	1715.3	234140
547	299209	163667323	23.3880	8.1783	2.73799	1.82815	1718.5	234998
548	300304	164566592	23.4094	8.1833	2.73878	1.82482	1721.6	235858
549	301401	165469149	23.4307	8.1882	2.73957	1.82149	1724.7	236720

FUNCTIONS OF NUMBERS

550
599

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
550	302500	166375000	23.4521	8.1932	2.74036	1.81818	1727.9	237583
551	303601	167284151	23.4734	8.1982	2.74115	1.81488	1731.0	238448
552	304704	168196608	23.4947	8.2031	2.74194	1.81159	1734.2	239314
553	305809	169112377	23.5160	8.2081	2.74273	1.80832	1737.3	240182
554	306916	170031464	23.5372	8.2130	2.74351	1.80505	1740.4	241051
555	308025	170953875	23.5584	8.2180	2.74429	1.80180	1743.6	241922
556	309136	171879616	23.5797	8.2229	2.74507	1.79856	1746.7	242795
557	310249	172808693	23.6008	8.2278	2.74586	1.79533	1749.9	243669
558	311364	173741112	23.6220	8.2327	2.74663	1.79211	1753.0	244545
559	312481	174676879	23.6432	8.2377	2.74741	1.78891	1756.2	245422
560	313600	175616000	23.6643	8.2426	2.74819	1.78571	1759.3	246301
561	314721	176558481	23.6854	8.2475	2.74896	1.78253	1762.4	247181
562	315844	177504328	23.7065	8.2524	2.74974	1.77936	1765.6	248063
563	316969	178453547	23.7276	8.2573	2.75051	1.77620	1768.7	248947
564	318096	179406144	23.7487	8.2621	2.75128	1.77305	1771.9	249832
565	319225	180362125	23.7697	8.2670	2.75205	1.76991	1775.0	250719
566	320356	181321496	23.7908	8.2719	2.75282	1.76678	1778.1	251607
567	321489	182284263	23.8118	8.2768	2.75358	1.76367	1781.3	252497
568	322624	183250432	23.8328	8.2816	2.75435	1.76056	1784.4	253388
569	323761	184220009	23.8537	8.2865	2.75511	1.75747	1787.6	254281
570	324900	185193000	23.8747	8.2913	2.75587	1.75439	1790.7	255176
571	326041	186169411	23.8956	8.2962	2.75664	1.75131	1793.8	256072
572	327184	187149248	23.9165	8.3010	2.75740	1.74825	1797.0	256970
573	328329	188132517	23.9374	8.3059	2.75815	1.74520	1800.1	257869
574	329476	189119224	23.9583	8.3107	2.75891	1.74216	1803.3	258770
575	330625	190109375	23.9792	8.3155	2.75967	1.73913	1806.4	259672
576	331776	191102976	24.0000	8.3203	2.76042	1.73611	1809.6	260576
577	332929	192100033	24.0208	8.3251	2.76118	1.73310	1812.7	261482
578	334084	193100552	24.0416	8.3300	2.76193	1.73010	1815.8	262389
579	335241	194104539	24.0624	8.3348	2.76268	1.72712	1819.0	263298
580	336400	195112000	24.0832	8.3396	2.76343	1.72414	1822.1	264208
581	337561	196122941	24.1039	8.3443	2.76418	1.72117	1825.3	265120
582	338724	197137368	24.1247	8.3491	2.76492	1.71821	1828.4	266033
583	339889	198155287	24.1454	8.3539	2.76567	1.71527	1831.5	266948
584	341056	199176704	24.1661	8.3587	2.76641	1.71233	1834.7	267865
585	342225	200201625	24.1868	8.3634	2.76716	1.70940	1837.8	268783
586	343396	201230056	24.2074	8.3682	2.76790	1.70648	1841.0	269703
587	344569	202262003	24.2281	8.3730	2.76864	1.70358	1844.1	270624
588	345744	203297472	24.2487	8.3777	2.76938	1.70068	1847.3	271547
589	346921	204336469	24.2693	8.3825	2.77012	1.69779	1850.4	272471
590	348100	205379000	24.2899	8.3872	2.77085	1.69492	1853.5	273397
591	349281	206425071	24.3105	8.3919	2.77159	1.69205	1856.7	274325
592	350464	207474688	24.3311	8.3967	2.77232	1.68919	1859.8	275254
593	351649	208527857	24.3516	8.4014	2.77305	1.68634	1863.0	276184
594	352836	209584584	24.3721	8.4061	2.77379	1.68350	1866.1	277117
595	354025	210644875	24.3926	8.4108	2.77452	1.68067	1869.2	278051
596	355216	211708736	24.4131	8.4155	2.77525	1.67785	1872.4	278986
597	356409	212776173	24.4336	8.4202	2.77597	1.67504	1875.5	279923
598	357604	213847192	24.4540	8.4249	2.77670	1.67224	1878.7	280862
599	358801	214921799	24.4745	8.4296	2.77743	1.66945	1881.8	281802

600
649

FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
600	360000	216000000	24.4949	8.4343	2.77815	1.66667	1885.0	282743
601	361201	217081801	24.5153	8.4390	2.77887	1.66389	1888.1	283687
602	362404	218167208	24.5357	8.4437	2.77960	1.66113	1891.2	284631
603	363609	219256227	24.5561	8.4484	2.78032	1.65837	1894.4	285578
604	364816	220348864	24.5764	8.4530	2.78104	1.65563	1897.5	286526
605	366025	221445125	24.5967	8.4577	2.78176	1.65289	1900.7	287475
606	367236	222545016	24.6171	8.4623	2.78247	1.65017	1903.8	288426
607	368449	223648543	24.6374	8.4670	2.78319	1.64745	1906.9	289379
608	369664	224755712	24.6577	8.4716	2.78390	1.64474	1910.1	290333
609	370881	225866529	24.6779	8.4763	2.78462	1.64204	1913.2	291289
610	372100	226981000	24.6982	8.4809	2.78533	1.63934	1916.4	292247
611	373321	228099131	24.7184	8.4856	2.78604	1.63666	1919.5	293206
612	374544	229220928	24.7386	8.4902	2.78675	1.63399	1922.7	294166
613	375769	230346397	24.7588	8.4948	2.78746	1.63132	1925.8	295128
614	376996	231475544	24.7790	8.4994	2.78817	1.62866	1928.9	296092
615	378225	232608375	24.7992	8.5040	2.78888	1.62602	1932.1	297057
616	379456	233744896	24.8193	8.5086	2.78958	1.62338	1935.2	298024
617	380689	234885113	24.8395	8.5132	2.79029	1.62075	1938.4	298992
618	381924	236029032	24.8596	8.5178	2.79099	1.61812	1941.5	299962
619	383161	237176659	24.8797	8.5224	2.79169	1.61551	1944.6	300934
620	384400	238328000	24.8998	8.5270	2.79239	1.61290	1947.8	301907
621	385641	239483061	24.9199	8.5316	2.79309	1.61031	1950.9	302882
622	386884	240641848	24.9399	8.5362	2.79379	1.60772	1954.1	303858
623	388129	241804367	24.9600	8.5408	2.79449	1.60514	1957.2	304836
624	389376	242970624	24.9800	8.5453	2.79518	1.60256	1960.4	305815
625	390625	244140625	25.0000	8.5499	2.79588	1.60000	1963.5	306796
626	391876	245314376	25.0200	8.5544	2.79657	1.59744	1966.6	307779
627	393129	246491883	25.0400	8.5590	2.79727	1.59490	1969.8	308763
628	394384	247673152	25.0599	8.5635	2.79796	1.59236	1972.9	309748
629	395641	248858189	25.0799	8.5681	2.79865	1.58983	1976.1	310736
630	396900	250047000	25.0998	8.5726	2.79934	1.58730	1979.2	311725
631	398161	251239591	25.1197	8.5772	2.80003	1.58479	1982.3	312715
632	399424	252435968	25.1396	8.5817	2.80072	1.58228	1985.5	313707
633	400689	253636137	25.1595	8.5862	2.80140	1.57978	1988.6	314700
634	401956	254840104	25.1794	8.5907	2.80209	1.57729	1991.8	315696
635	403225	256047875	25.1992	8.5952	2.80277	1.57480	1994.9	316692
636	404496	257259456	25.2190	8.5997	2.80346	1.57233	1998.1	317690
637	405769	258474853	25.2389	8.6043	2.80414	1.56986	2001.2	318690
638	407044	259694072	25.2587	8.6088	2.80482	1.56740	2004.3	319692
639	408321	260917119	25.2784	8.6132	2.80550	1.56495	2007.5	320695
640	409600	262144000	25.2982	8.6177	2.80618	1.56250	2010.6	321699
641	410881	263374721	25.3180	8.6222	2.80686	1.56006	2013.8	322705
642	412164	264609288	25.3377	8.6267	2.80754	1.55763	2016.9	323713
643	413449	265847707	25.3574	8.6312	2.80821	1.55521	2020.0	324722
644	414736	267089984	25.3772	8.6357	2.80889	1.55280	2023.2	325733
645	416025	268336125	25.3969	8.6401	2.80956	1.55039	2026.3	326745
646	417316	269586136	25.4165	8.6446	2.81023	1.54799	2029.5	327759
647	418609	270840023	25.4362	8.6490	2.81090	1.54560	2032.6	328775
648	419904	272097792	25.4558	8.6535	2.81158	1.54321	2035.8	329792
649	421201	273359449	25.4755	8.6579	2.81224	1.54083	2038.9	330810

FUNCTIONS OF NUMBERS

650
699

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	Area
650	422500	274625000	25.4951	8.6624	2.81291	1.53846	2042.0	331831
651	423801	275894451	25.5147	8.6668	2.81358	1.53610	2045.2	332853
652	425104	277167808	25.5343	8.6713	2.81425	1.53374	2048.3	333876
653	426409	278445077	25.5539	8.6757	2.81491	1.53139	2051.5	334901
654	427716	279726264	25.5734	8.6801	2.81558	1.52905	2054.6	335927
655	429025	281011375	25.5930	8.6845	2.81624	1.52672	2057.7	336955
656	430336	282300416	25.6125	8.6890	2.81690	1.52439	2060.9	337985
657	431649	283593393	25.6320	8.6934	2.81757	1.52207	2064.0	339016
658	432964	284890312	25.6515	8.6978	2.81823	1.51976	2067.2	340049
659	434281	286191179	25.6710	8.7022	2.81889	1.51745	2070.3	341083
660	435600	287496000	25.6905	8.7066	2.81954	1.51515	2073.5	342119
661	436921	288804781	25.7099	8.7110	2.82020	1.51286	2076.6	343157
662	438244	290117528	25.7294	8.7154	2.82086	1.51057	2079.7	344196
663	439569	291434247	25.7488	8.7198	2.82151	1.50830	2082.9	345237
664	440896	292754944	25.7682	8.7241	2.82217	1.50602	2086.0	346279
665	442225	294079625	25.7876	8.7285	2.82282	1.50376	2089.2	347323
666	443556	295408296	25.8070	8.7329	2.82347	1.50150	2092.3	348368
667	444889	296740963	25.8263	8.7373	2.82413	1.49925	2095.4	349415
668	446224	298077632	25.8457	8.7416	2.82478	1.49701	2098.6	350464
669	447561	299418309	25.8650	8.7460	2.82543	1.49477	2101.7	351514
670	448900	300763000	25.8844	8.7503	2.82607	1.49254	2104.9	352565
671	450241	302111711	25.9037	8.7547	2.82672	1.49031	2108.0	353618
672	451584	303464448	25.9230	8.7590	2.82737	1.48810	2111.2	354673
673	452929	304821217	25.9422	8.7634	2.82802	1.48588	2114.3	355730
674	454276	306182024	25.9615	8.7677	2.82866	1.48368	2117.4	356788
675	455625	307546875	25.9808	8.7721	2.82930	1.48148	2120.6	357847
676	456976	308915776	26.0000	8.7764	2.82995	1.47929	2123.7	358908
677	458329	310288733	26.0192	8.7807	2.83059	1.47710	2126.9	359971
678	459684	311665752	26.0384	8.7850	2.83123	1.47493	2130.0	361035
679	461041	313046839	26.0576	8.7893	2.83187	1.47275	2133.1	362101
680	462400	314432000	26.0768	8.7937	2.83251	1.47059	2136.3	363168
681	463761	315821241	26.0960	8.7980	2.83315	1.46843	2139.4	364237
682	465124	317214568	26.1151	8.8023	2.83378	1.46628	2142.6	365308
683	466489	318611987	26.1343	8.8066	2.83442	1.46413	2145.7	366380
684	467856	320013504	26.1534	8.8109	2.83506	1.46199	2148.8	367453
685	469225	321419125	26.1725	8.8152	2.83569	1.45985	2152.0	368528
686	470596	322828856	26.1916	8.8194	2.83632	1.45773	2155.1	369605
687	471969	324242703	26.2107	8.8237	2.83696	1.45560	2158.3	370684
688	473344	325660672	26.2298	8.8280	2.83759	1.45349	2161.4	371764
689	474721	327082769	26.2488	8.8323	2.83822	1.45138	2164.6	372845
690	476100	328509000	26.2679	8.8366	2.83885	1.44928	2167.7	373928
691	477481	329939371	26.2869	8.8408	2.83948	1.44718	2170.8	375013
692	478864	331373888	26.3059	8.8451	2.84011	1.44509	2174.0	376099
693	480249	332812557	26.3249	8.8493	2.84073	1.44300	2177.1	377187
694	481636	334255384	26.3439	8.8536	2.84136	1.44092	2180.3	378276
695	483025	335702375	26.3629	8.8578	2.84198	1.43885	2183.4	379367
696	484416	337153536	26.3818	8.8621	2.84261	1.43678	2186.5	380459
697	485809	338608873	26.4008	8.8663	2.84323	1.43472	2189.7	381553
698	487204	340068392	26.4197	8.8706	2.84386	1.43266	2192.8	382649
699	488601	341532099	26.4386	8.8748	2.84448	1.43062	2196.0	383746

700
749

FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	Area
700	490000	343000000	26.4575	8.8790	2.84510	1.42857	2199.1	384845
701	491401	344472101	26.4764	8.8833	2.84572	1.42653	2202.3	385945
702	492804	345948408	26.4953	8.8875	2.84634	1.42450	2205.4	387047
703	494209	347428927	26.5141	8.8917	2.84696	1.42248	2208.5	388151
704	495616	348913664	26.5330	8.8959	2.84757	1.42045	2211.7	389256
705	497025	350402625	26.5518	8.9001	2.84819	1.41844	2214.8	390363
706	498436	351895816	26.5707	8.9043	2.84880	1.41643	2218.0	391471
707	499849	353393243	26.5895	8.9085	2.84942	1.41443	2221.1	392580
708	501264	354894912	26.6083	8.9127	2.85003	1.41243	2224.2	393692
709	502681	356400829	26.6271	8.9169	2.85065	1.41044	2227.4	394805
710	504100	357911000	26.6458	8.9211	2.85126	1.40845	2230.5	395919
711	505521	359425431	26.6646	8.9253	2.85187	1.40647	2233.7	397035
712	506944	360944128	26.6833	8.9295	2.85248	1.40449	2236.8	398153
713	508369	362467097	26.7021	8.9337	2.85309	1.40252	2240.0	399272
714	509796	363994344	26.7208	8.9378	2.85370	1.40056	2243.1	400393
715	511225	365525875	26.7395	8.9420	2.85431	1.39860	2246.2	401515
716	512656	367061696	26.7582	8.9462	2.85491	1.39665	2249.4	402639
717	514089	368601813	26.7769	8.9503	2.85552	1.39470	2252.5	403765
718	515524	370146232	26.7955	8.9545	2.85612	1.39276	2255.7	404892
719	516961	371694959	26.8142	8.9587	2.85673	1.39082	2258.8	406020
720	518400	373248000	26.8328	8.9628	2.85733	1.38889	2261.9	407150
721	519841	374805361	26.8514	8.9670	2.85794	1.38696	2265.1	408282
722	521284	376367048	26.8701	8.9711	2.85854	1.38504	2268.2	409415
723	522729	377933067	26.8887	8.9752	2.85914	1.38313	2271.4	410550
724	524176	379503424	26.9072	8.9794	2.85974	1.38122	2274.5	411687
725	525625	381078125	26.9258	8.9835	2.86034	1.37931	2277.7	412825
726	527076	382657176	26.9444	8.9876	2.86094	1.37741	2280.8	413965
727	528529	384240583	26.9629	8.9918	2.86153	1.37552	2283.9	415106
728	529984	385828352	26.9815	8.9959	2.86213	1.37363	2287.1	416248
729	531441	387420489	27.0000	9.0000	2.86273	1.37174	2290.2	417393
730	532900	389017000	27.0185	9.0041	2.86332	1.36986	2293.4	418539
731	534361	390617891	27.0370	9.0082	2.86392	1.36799	2296.5	419686
732	535824	392223168	27.0555	9.0123	2.86451	1.36612	2299.6	420835
733	537289	393832837	27.0740	9.0164	2.86510	1.36426	2302.8	421986
734	538756	395446904	27.0924	9.0205	2.86570	1.36240	2305.9	423138
735	540225	397065375	27.1109	9.0246	2.86629	1.36054	2309.1	424292
736	541696	398688256	27.1293	9.0287	2.86688	1.35870	2312.2	425447
737	543169	400315553	27.1477	9.0328	2.86747	1.35685	2315.4	426604
738	544644	401947272	27.1662	9.0369	2.86806	1.35501	2318.5	427762
739	546121	403583419	27.1846	9.0410	2.86864	1.35318	2321.6	428922
740	547600	405224000	27.2029	9.0450	2.86923	1.35135	2324.8	430084
741	549081	406869021	27.2213	9.0491	2.86982	1.34953	2327.9	431247
742	550564	408518488	27.2397	9.0532	2.87040	1.34771	2331.1	432412
743	552049	410172407	27.2580	9.0572	2.87099	1.34590	2334.2	433578
744	553536	411830784	27.2764	9.0613	2.87157	1.34409	2337.3	434746
745	555025	413493625	27.2947	9.0654	2.87216	1.34228	2340.5	435916
746	556516	415160936	27.3130	9.0694	2.87274	1.34048	2343.6	437087
747	558009	416832723	27.3313	9.0735	2.87332	1.33869	2346.8	438259
748	559504	418508992	27.3496	9.0775	2.87390	1.33690	2349.9	439433
749	561001	420189749	27.3679	9.0816	2.87448	1.33511	2353.1	440609

FUNCTIONS OF NUMBERS

750
799

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
750	562500	421875000	27.3861	9.0856	2.87506	1.33333	2356.2	441786
751	564001	423564751	27.4044	9.0896	2.87564	1.33156	2359.3	442965
752	565504	425259008	27.4226	9.0937	2.87622	1.32979	2362.5	444146
753	567009	426957777	27.4408	9.0977	2.87680	1.32802	2365.6	445328
754	568516	428661064	27.4591	9.1017	2.87737	1.32626	2368.8	446511
755	570025	430368875	27.4773	9.1057	2.87795	1.32450	2371.9	447697
756	571536	432081216	27.4955	9.1098	2.87852	1.32275	2375.0	448883
757	573049	433798093	27.5136	9.1138	2.87910	1.32100	2378.2	450072
758	574564	435519512	27.5318	9.1178	2.87967	1.31926	2381.3	451262
759	576081	437245479	27.5500	9.1218	2.88024	1.31752	2384.5	452453
760	577600	438976000	27.5681	9.1258	2.88081	1.31579	2387.6	453646
761	579121	440711081	27.5862	9.1298	2.88138	1.31406	2390.8	454841
762	580644	442450728	27.6043	9.1338	2.88196	1.31234	2393.9	456037
763	582169	444194947	27.6225	9.1378	2.88252	1.31062	2397.0	457234
764	583696	445943744	27.6405	9.1418	2.88309	1.30890	2400.2	458434
765	585225	447697125	27.6586	9.1458	2.88366	1.30719	2403.3	459635
766	586756	449455096	27.6767	9.1498	2.88423	1.30548	2406.5	460837
767	588289	451217663	27.6948	9.1537	2.88480	1.30378	2409.6	462041
768	589824	452984832	27.7128	9.1577	2.88536	1.30208	2412.7	463247
769	591361	454756609	27.7308	9.1617	2.88593	1.30039	2415.9	464454
770	592900	456533000	27.7489	9.1657	2.88649	1.29870	2419.0	465663
771	594441	458314011	27.7669	9.1696	2.88705	1.29702	2422.2	466873
772	595984	460099648	27.7849	9.1736	2.88762	1.29534	2425.3	468085
773	597529	461889917	27.8029	9.1775	2.88818	1.29366	2428.5	469298
774	599076	463684824	27.8209	9.1815	2.88874	1.29199	2431.6	470513
775	600625	465484375	27.8388	9.1855	2.88930	1.29032	2434.7	471730
776	602176	467288576	27.8568	9.1894	2.88986	1.28866	2437.9	472948
777	603729	469097433	27.8747	9.1933	2.89042	1.28700	2441.0	474168
778	605284	470910952	27.8927	9.1973	2.89098	1.28535	2444.2	475389
779	606841	472729139	27.9106	9.2012	2.89154	1.28370	2447.3	476612
780	608400	474552000	27.9285	9.2052	2.89209	1.28205	2450.4	477836
781	609961	476379541	27.9464	9.2091	2.89265	1.28041	2453.6	479062
782	611524	478211768	27.9643	9.2130	2.89321	1.27877	2456.7	480290
783	613089	480048687	27.9821	9.2170	2.89376	1.27714	2459.9	481519
784	614656	481890304	28.0000	9.2209	2.89432	1.27551	2463.0	482750
785	616225	483736625	28.0179	9.2248	2.89487	1.27389	2466.2	483982
786	617796	485587656	28.0357	9.2287	2.89542	1.27226	2469.3	485216
787	619369	487443403	28.0535	9.2326	2.89597	1.27065	2472.4	486451
788	620944	489303872	28.0713	9.2365	2.89653	1.26904	2475.6	487688
789	622521	491169069	28.0891	9.2404	2.89708	1.26743	2478.7	488927
790	624100	493039000	28.1069	9.2443	2.89763	1.26582	2481.9	490167
791	625681	494913671	28.1247	9.2482	2.89818	1.26422	2485.0	491409
792	627264	496793088	28.1425	9.2521	2.89873	1.26263	2488.1	492652
793	628849	498677257	28.1603	9.2560	2.89927	1.26103	2491.3	493897
794	630436	500566184	28.1780	9.2599	2.89982	1.25945	2494.4	495143
795	632025	502459875	28.1957	9.2638	2.90037	1.25786	2497.6	496391
796	633616	504358336	28.2135	9.2677	2.90091	1.25628	2500.7	497641
797	635209	506261573	28.2312	9.2716	2.90146	1.25471	2503.8	498892
798	636804	508169592	28.2489	9.2754	2.90200	1.25313	2507.0	500145
799	638401	510082399	28.2666	9.2793	2.90255	1.25156	2510.1	501399

800
849

FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	Area
800	640000	512000000	28.2843	9.2832	2.90309	1.25000	2513.3	502655
801	641601	513922401	28.3019	9.2870	2.90363	1.24844	2516.4	503912
802	643204	515849608	28.3196	9.2909	2.90417	1.24688	2519.6	505171
803	644809	517781627	28.3373	9.2948	2.90472	1.24533	2522.7	506432
804	646416	519718464	28.3549	9.2986	2.90526	1.24378	2525.8	507694
805	648025	521660125	28.3725	9.3025	2.90580	1.24224	2529.0	508958
806	649636	523606616	28.3901	9.3063	2.90634	1.24069	2532.1	510223
807	651249	525557943	28.4077	9.3102	2.90687	1.23916	2535.3	511490
808	652864	527514112	28.4253	9.3140	2.90741	1.23762	2538.4	512758
809	654481	529475129	28.4429	9.3179	2.90795	1.23609	2541.5	514028
810	656100	531441000	28.4605	9.3217	2.90849	1.23457	2544.7	515300
811	657721	533411731	28.4781	9.3255	2.90902	1.23305	2547.8	516573
812	659344	535387328	28.4956	9.3294	2.90956	1.23153	2551.0	517848
813	660969	537367797	28.5132	9.3332	2.91009	1.23001	2554.1	519124
814	662596	539353144	28.5307	9.3370	2.91062	1.22850	2557.3	520402
815	664225	541343375	28.5482	9.3408	2.91116	1.22699	2560.4	521681
816	665856	543338496	28.5657	9.3447	2.91169	1.22549	2563.5	522962
817	667489	545338513	28.5832	9.3485	2.91222	1.22399	2566.7	524245
818	669124	547343432	28.6007	9.3523	2.91275	1.22249	2569.8	525529
819	670761	549353259	28.6182	9.3561	2.91328	1.22100	2573.0	526814
820	672400	551368000	28.6356	9.3599	2.91381	1.21951	2576.1	528102
821	674041	553387661	28.6531	9.3637	2.91434	1.21803	2579.2	529391
822	675684	555412248	28.6705	9.3675	2.91487	1.21655	2582.4	530681
823	677329	557441767	28.6880	9.3713	2.91540	1.21507	2585.5	531973
824	678976	559476224	28.7054	9.3751	2.91593	1.21359	2588.7	533267
825	680625	561515625	28.7228	9.3789	2.91645	1.21212	2591.8	534562
826	682276	563559976	28.7402	9.3827	2.91698	1.21065	2595.0	535858
827	683929	565609283	28.7576	9.3865	2.91751	1.20919	2598.1	537157
828	685584	567663552	28.7750	9.3902	2.91803	1.20773	2601.2	538456
829	687241	569722789	28.7924	9.3940	2.91855	1.20627	2604.4	539758
830	688900	571787000	28.8097	9.3978	2.91908	1.20482	2607.5	541061
831	690561	573856191	28.8271	9.4016	2.91960	1.20337	2610.7	542365
832	692224	575930368	28.8444	9.4053	2.92012	1.20192	2613.8	543671
833	693889	578009537	28.8617	9.4091	2.92065	1.20048	2616.9	544979
834	695556	580093704	28.8791	9.4129	2.92117	1.19904	2620.1	546288
835	697225	582182875	28.8964	9.4166	2.92169	1.19760	2623.2	547599
836	698896	584277056	28.9137	9.4204	2.92221	1.19617	2626.4	548912
837	700569	586376253	28.9310	9.4241	2.92273	1.19474	2629.5	550226
838	702244	588480472	28.9482	9.4279	2.92324	1.19332	2632.7	551541
839	703921	590589719	28.9655	9.4316	2.92376	1.19190	2635.8	552858
840	705600	592704000	28.9828	9.4354	2.92428	1.19048	2638.9	554177
841	707281	594823321	29.0000	9.4391	2.92480	1.18906	2642.1	555497
842	708964	596947688	29.0172	9.4429	2.92531	1.18765	2645.2	556819
843	710649	599077107	29.0345	9.4466	2.92583	1.18624	2648.4	558142
844	712336	601211584	29.0517	9.4503	2.92634	1.18483	2651.5	559467
845	714025	603351125	29.0689	9.4541	2.92686	1.18343	2654.6	560794
846	715716	605495736	29.0861	9.4578	2.92737	1.18203	2657.8	562122
847	717409	607645423	29.1033	9.4615	2.92788	1.18064	2660.9	563452
848	719104	609800192	29.1204	9.4652	2.92840	1.17925	2664.1	564783
849	720801	611960049	29.1376	9.4690	2.92891	1.17786	2667.2	566116

FUNCTIONS OF NUMBERS

850
899

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
850	722500	614125000	29.1548	9.4727	2.92942	1.17647	2670.4	567450
851	724201	616295051	29.1719	9.4764	2.92993	1.17509	2673.5	568786
852	725904	618470208	29.1890	9.4801	2.93044	1.17371	2676.6	570124
853	727609	620650477	29.2062	9.4838	2.93095	1.17233	2679.8	571463
854	729316	622835864	29.2233	9.4875	2.93146	1.17096	2682.9	572803
855	731025	625026375	29.2404	9.4912	2.93197	1.16959	2686.1	574146
856	732736	627222016	29.2575	9.4949	2.93247	1.16822	2689.2	575490
857	734449	629422793	29.2746	9.4986	2.93298	1.16686	2692.3	576835
858	736164	631628712	29.2916	9.5023	2.93349	1.16550	2695.5	578182
859	737881	633839779	29.3087	9.5060	2.93399	1.16414	2698.6	579530
860	739600	636056000	29.3258	9.5097	2.93450	1.16279	2701.8	580880
861	741321	638277381	29.3428	9.5134	2.93500	1.16144	2704.9	582232
862	743044	640503928	29.3598	9.5171	2.93551	1.16009	2708.1	583585
863	744769	642735647	29.3769	9.5207	2.93601	1.15875	2711.2	584940
864	746496	644972544	29.3939	9.5244	2.93651	1.15741	2714.3	586297
865	748225	647214625	29.4109	9.5281	2.93702	1.15607	2717.5	587655
866	749956	649461896	29.4279	9.5317	2.93752	1.15473	2720.6	589014
867	751689	651714363	29.4449	9.5354	2.93802	1.15340	2723.8	590375
868	753424	653972032	29.4618	9.5391	2.93852	1.15207	2726.9	591738
869	755161	656234909	29.4788	9.5427	2.93902	1.15075	2730.0	593102
870	756900	658503000	29.4958	9.5464	2.93952	1.14943	2733.2	594468
871	758641	660776311	29.5127	9.5501	2.94002	1.14811	2736.3	595835
872	760384	663054848	29.5296	9.5537	2.94052	1.14679	2739.5	597204
873	762129	665338617	29.5466	9.5574	2.94101	1.14548	2742.6	598575
874	763876	667627624	29.5635	9.5610	2.94151	1.14416	2745.8	599947
875	765625	669921875	29.5804	9.5647	2.94201	1.14286	2748.9	601320
876	767376	672221376	29.5973	9.5683	2.94250	1.14155	2752.0	602696
877	769129	674526133	29.6142	9.5719	2.94300	1.14025	2755.2	604073
878	770884	676836152	29.6311	9.5756	2.94349	1.13895	2758.3	605451
879	772641	679151439	29.6479	9.5792	2.94399	1.13766	2761.5	606831
880	774400	681472000	29.6648	9.5828	2.94448	1.13636	2764.6	608212
881	776161	683797841	29.6816	9.5865	2.94498	1.13507	2767.7	609595
882	777924	686128968	29.6985	9.5901	2.94547	1.13379	2770.9	610980
883	779689	688465387	29.7153	9.5937	2.94596	1.13250	2774.0	612366
884	781456	690807104	29.7321	9.5973	2.94645	1.13122	2777.2	613754
885	783225	693154125	29.7489	9.6010	2.94694	1.12994	2780.3	615143
886	784996	695506456	29.7658	9.6046	2.94743	1.12867	2783.5	616534
887	786769	697864103	29.7825	9.6082	2.94792	1.12740	2786.6	617927
888	788544	700227072	29.7993	9.6118	2.94841	1.12613	2789.7	619321
889	790321	702595369	29.8161	9.6154	2.94890	1.12486	2792.9	620717
890	792100	704969000	29.8329	9.6190	2.94939	1.12360	2796.0	622114
891	793881	707347971	29.8496	9.6226	2.94988	1.12233	2799.2	623513
892	795664	709732288	29.8664	9.6262	2.95036	1.12108	2802.3	624913
893	797449	712121957	29.8831	9.6298	2.95085	1.11982	2805.4	626315
894	799236	714516984	29.8998	9.6334	2.95134	1.11857	2808.6	627718
895	801025	716917375	29.9166	9.6370	2.95182	1.11732	2811.7	629124
896	802816	719323136	29.9333	9.6406	2.95231	1.11607	2814.9	630530
897	804609	721734273	29.9500	9.6442	2.95279	1.11483	2818.0	631938
898	806404	724150792	29.9666	9.6477	2.95328	1.11359	2821.2	633348
899	808201	726572699	29.9833	9.6513	2.95376	1.11235	2824.3	634760

900
949

FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
900	810000	729000000	30.0000	9.6549	2.95424	1.11111	2827.4	636173
901	811801	731432701	30.0167	9.6585	2.95472	1.10988	2830.6	637587
902	813604	733870808	30.0333	9.6620	2.95521	1.10865	2833.7	639003
903	815409	736314327	30.0500	9.6656	2.95569	1.10742	2836.9	640421
904	817216	738763264	30.0666	9.6692	2.95617	1.10619	2840.0	641840
905	819025	741217625	30.0832	9.6727	2.95665	1.10497	2843.1	643261
906	820836	743677416	30.0998	9.6763	2.95713	1.10375	2846.3	644683
907	822649	746142643	30.1164	9.6799	2.95761	1.10254	2849.4	646107
908	824464	748613312	30.1330	9.6834	2.95809	1.10132	2852.6	647533
909	826281	751089429	30.1496	9.6870	2.95856	1.10011	2855.7	648960
910	828100	753571000	30.1662	9.6905	2.95904	1.09890	2858.8	650388
911	829921	756058031	30.1828	9.6941	2.95952	1.09769	2862.0	651818
912	831744	758550528	30.1993	9.6976	2.95999	1.09649	2865.1	653250
913	833569	761048497	30.2159	9.7012	2.96047	1.09529	2868.3	654684
914	835396	763551944	30.2324	9.7047	2.96095	1.09409	2871.4	656118
915	837225	766060875	30.2490	9.7082	2.96142	1.09290	2874.6	657555
916	839056	768575296	30.2655	9.7118	2.96190	1.09170	2877.7	658993
917	840889	771095213	30.2820	9.7153	2.96237	1.09051	2880.8	660433
918	842724	773620632	30.2985	9.7188	2.96284	1.08932	2884.0	661874
919	844561	776151559	30.3150	9.7224	2.96332	1.08814	2887.1	663317
920	846400	778688000	30.3315	9.7259	2.96379	1.08696	2890.3	664761
921	848241	781229961	30.3480	9.7294	2.96426	1.08578	2893.4	666207
922	850084	783777448	30.3645	9.7329	2.96473	1.08460	2896.5	667654
923	851929	786330467	30.3809	9.7364	2.96520	1.08342	2899.7	669103
924	853776	788889024	30.3974	9.7400	2.96567	1.08225	2902.8	670554
925	855625	791453125	30.4138	9.7435	2.96614	1.08108	2906.0	672006
926	857476	794022776	30.4302	9.7470	2.96661	1.07991	2909.1	673460
927	859329	796597983	30.4467	9.7505	2.96708	1.07875	2912.3	674915
928	861184	799178752	30.4631	9.7540	2.96755	1.07759	2915.4	676372
929	863041	801765089	30.4795	9.7575	2.96802	1.07643	2918.5	677831
930	864900	804357000	30.4959	9.7610	2.96848	1.07527	2921.7	679291
931	866761	806954491	30.5123	9.7645	2.96895	1.07411	2924.8	680752
932	868624	809557568	30.5287	9.7680	2.96942	1.07296	2928.0	682216
933	870489	812166237	30.5450	9.7715	2.96988	1.07181	2931.1	683680
934	872356	814780504	30.5614	9.7750	2.97035	1.07066	2934.2	685147
935	874225	817400375	30.5778	9.7785	2.97081	1.06952	2937.4	686615
936	876096	820025856	30.5941	9.7819	2.97128	1.06838	2940.5	688084
937	877969	822656953	30.6105	9.7854	2.97174	1.06724	2943.7	689555
938	879844	825293672	30.6268	9.7889	2.97220	1.06610	2946.8	691028
939	881721	827936019	30.6431	9.7924	2.97267	1.06496	2950.0	692502
940	883600	830584000	30.6594	9.7959	2.97313	1.06383	2953.1	693978
941	885481	833237621	30.6757	9.7993	2.97359	1.06270	2956.2	695455
942	887364	835896888	30.6920	9.8028	2.97405	1.06157	2959.4	696934
943	889249	838561807	30.7083	9.8063	2.97451	1.06045	2962.5	698415
944	891136	841232384	30.7246	9.8097	2.97497	1.05932	2965.7	699897
945	893025	843908625	30.7409	9.8132	2.97543	1.05820	2968.8	701380
946	894916	846590536	30.7571	9.8167	2.97589	1.05708	2971.9	702865
947	896809	849278123	30.7734	9.8201	2.97635	1.05597	2975.1	704352
948	898704	851971392	30.7896	9.8236	2.97681	1.05485	2978.2	705840
949	900601	854670349	30.8058	9.8270	2.97727	1.05374	2981.4	707330

FUNCTIONS OF NUMBERS

950
999

No.	Square	Cube	Square Root	Cube Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
950	902500	857375000	30.8221	9.8305	2.97772	1.05263	2984.5	708822
951	904401	860085351	30.8383	9.8339	2.97818	1.05152	2987.7	710315
952	906304	862801408	30.8545	9.8374	2.97864	1.05042	2990.8	711809
953	908209	865523177	30.8707	9.8408	2.97909	1.04932	2993.9	713306
954	910116	868250664	30.8869	9.8443	2.97955	1.04822	2997.1	714803
955	912025	870983875	30.9031	9.8477	2.98000	1.04712	3000.2	716303
956	913936	873722816	30.9192	9.8511	2.98046	1.04603	3003.4	717804
957	915849	876467493	30.9354	9.8546	2.98091	1.04493	3006.5	719306
958	917764	879217912	30.9516	9.8580	2.98137	1.04384	3009.6	720810
959	919681	881974079	30.9677	9.8614	2.98182	1.04275	3012.8	722316
960	921600	884736000	30.9839	9.8648	2.98227	1.04167	3015.9	723823
961	923521	887503681	31.0000	9.8683	2.98272	1.04058	3019.1	725332
962	925444	890277128	31.0161	9.8717	2.98318	1.03950	3022.2	726842
963	927369	893056347	31.0322	9.8751	2.98363	1.03842	3025.4	728354
964	929296	895841344	31.0483	9.8785	2.98408	1.03734	3028.5	729867
965	931225	898632125	31.0644	9.8819	2.98453	1.03627	3031.6	731382
966	933156	901428696	31.0805	9.8854	2.98498	1.03520	3034.8	732899
967	935089	904231063	31.0966	9.8888	2.98543	1.03413	3037.9	734417
968	937024	907039232	31.1127	9.8922	2.98588	1.03306	3041.1	735937
969	938961	909853209	31.1288	9.8956	2.98632	1.03199	3044.2	737458
970	940900	912673000	31.1448	9.8990	2.98677	1.03093	3047.3	738981
971	942841	915498611	31.1609	9.9024	2.98722	1.02987	3050.5	740506
972	944784	918330048	31.1769	9.9058	2.98767	1.02881	3053.6	742032
973	946729	921167317	31.1929	9.9092	2.98811	1.02775	3056.8	743559
974	948676	924010424	31.2090	9.9126	2.98856	1.02669	3059.9	745088
975	950625	926859375	31.2250	9.9160	2.98900	1.02564	3063.1	746619
976	952576	929714176	31.2410	9.9194	2.98945	1.02459	3066.2	748151
977	954529	932574833	31.2570	9.9227	2.98989	1.02354	3069.3	749685
978	956484	935441352	31.2730	9.9261	2.99034	1.02249	3072.5	751221
979	958441	938313739	31.2890	9.9295	2.99078	1.02145	3075.6	752758
980	960400	941192000	31.3050	9.9329	2.99123	1.02041	3078.8	754296
981	962361	944076141	31.3209	9.9363	2.99167	1.01937	3081.9	755837
982	964324	946966168	31.3369	9.9396	2.99211	1.01833	3085.0	757378
983	966289	949862087	31.3528	9.9430	2.99255	1.01729	3088.2	758922
984	968256	952763904	31.3688	9.9464	2.99300	1.01626	3091.3	760466
985	970225	955671625	31.3847	9.9497	2.99344	1.01523	3094.5	762013
986	972196	958585256	31.4006	9.9531	2.99388	1.01420	3097.6	763561
987	974169	961504803	31.4166	9.9565	2.99432	1.01317	3100.8	765111
988	976144	964430272	31.4325	9.9598	2.99476	1.01215	3103.9	766662
989	978121	967361669	31.4484	9.9632	2.99520	1.01112	3107.0	768214
990	980100	970299000	31.4643	9.9666	2.99564	1.01010	3110.2	769769
991	982081	973242271	31.4802	9.9699	2.99607	1.00908	3113.3	771325
992	984064	976191488	31.4960	9.9733	2.99651	1.00806	3116.5	772882
993	986049	979146657	31.5119	9.9766	2.99695	1.00705	3119.6	774441
994	988036	982107784	31.5278	9.9800	2.99739	1.00604	3122.7	776002
995	990025	985074875	31.5436	9.9833	2.99782	1.00503	3125.9	777564
996	992016	988047936	31.5595	9.9866	2.99826	1.00402	3129.0	779128
997	994009	991026973	31.5753	9.9900	2.99870	1.00301	3132.2	780693
998	996004	994011992	31.5911	9.9933	2.99913	1.00200	3135.3	782260
999	998001	997002999	31.6070	9.9967	2.99957	1.00100	3138.5	783828

NATURAL TRIGONOMETRIC FUNCTIONS

0°						179°	1°						178°
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.00000	1.0000	0.00000	Infinite	1.0000	Infinite	0.01745	0.99985	0.01745	57.290	1.0001	57.299	60
1	.00029	.0000	.00029	3437.7	.0000	3437.7	.01774	.99984	.01775	56.350	.0001	56.359	59
2	.00058	.0000	.00058	1718.9	.0000	1718.9	.01803	.99984	.01804	55.441	.0001	55.450	58
3	.00087	.0000	.00087	1145.9	.0000	1145.9	.01832	.99983	.01833	54.561	.0002	54.570	57
4	.00116	.0000	.00116	859.44	.0000	859.44	.01861	.99983	.01862	53.708	.0002	53.718	56
5	0.00145	1.0000	0.00145	687.55	1.0000	687.55	0.01891	0.99982	0.01891	52.882	1.0002	52.891	55
6	.00174	.0000	.00174	572.96	.0000	572.96	.01920	.99981	.01920	52.081	.0002	52.090	54
7	.00204	.0000	.00204	491.11	.0000	491.11	.01949	.99981	.01949	51.303	.0002	51.313	53
8	.00233	.0000	.00233	429.72	.0000	429.72	.01978	.99980	.01978	50.548	.0002	50.558	52
9	.00262	.0000	.00262	381.97	.0000	381.97	.02007	.99980	.02007	49.816	.0002	49.826	51
10	0.00291	0.99999	0.00291	343.77	1.0000	343.77	0.02036	0.99979	0.02036	49.104	1.0002	49.114	50
11	.00320	.99999	.00320	312.52	.0000	312.52	.02065	.99979	.02066	48.412	.0002	48.422	49
12	.00349	.99999	.00349	286.48	.0000	286.48	.02094	.99978	.02095	47.739	.0002	47.750	48
13	.00378	.99999	.00378	264.44	.0000	264.44	.02123	.99977	.02124	47.085	.0002	47.096	47
14	.00407	.99999	.00407	245.55	.0000	245.55	.02152	.99977	.02153	46.449	.0002	46.460	46
15	0.00436	0.99999	0.00436	229.18	1.0000	229.18	0.02181	0.99976	0.02182	45.829	1.0002	45.840	45
16	.00465	.99999	.00465	214.86	.0000	214.86	.02210	.99975	.02211	45.226	.0002	45.237	44
17	.00494	.99999	.00494	202.22	.0000	202.22	.02240	.99975	.02240	44.638	.0002	44.650	43
18	.00524	.99999	.00524	190.98	.0000	190.99	.02269	.99974	.02269	44.066	.0002	44.077	42
19	.00553	.99998	.00553	180.93	.0000	180.93	.02298	.99974	.02298	43.508	.0003	43.520	41
20	0.00582	0.99998	0.00582	171.88	1.0000	171.89	0.02326	0.99973	0.02327	42.964	1.0003	42.976	40
21	.00611	.99998	.00611	163.70	.0000	163.70	.02356	.99972	.02357	42.433	.0003	42.445	39
22	.00640	.99998	.00640	156.26	.0000	156.26	.02385	.99971	.02386	41.916	.0003	41.928	38
23	.00669	.99998	.00669	149.46	.0000	149.47	.02414	.99971	.02415	41.410	.0003	41.423	37
24	.00698	.99997	.00698	143.24	.0000	143.24	.02443	.99970	.02444	40.917	.0003	40.930	36
25	0.00727	0.99997	0.00727	137.51	1.0000	137.51	0.02472	0.99969	0.02473	40.436	1.0003	40.448	35
26	.00756	.99997	.00756	132.22	.0000	132.22	.02501	.99969	.02502	39.965	.0003	39.978	34
27	.00785	.99997	.00785	127.32	.0000	127.32	.02530	.99968	.02531	39.506	.0003	39.518	33
28	.00814	.99997	.00814	122.77	.0000	122.78	.02559	.99967	.02560	39.057	.0003	39.069	32
29	.00843	.99996	.00844	118.54	.0000	118.54	.02589	.99966	.02589	38.618	.0003	38.631	31
30	0.00873	0.99996	0.00873	114.59	1.0000	114.59	0.02618	0.99966	0.02618	38.188	1.0003	38.201	30
31	.00902	.99996	.00902	110.89	.0000	110.90	.02647	.99965	.02648	37.769	.0003	37.782	29
32	.00931	.99996	.00931	107.43	.0000	107.43	.02676	.99964	.02677	37.358	.0003	37.371	28
33	.00960	.99995	.00960	104.17	.0000	104.17	.02705	.99963	.02706	36.956	.0004	36.969	27
34	.00989	.99995	.00989	101.11	.0000	101.11	.02734	.99963	.02735	36.563	.0004	36.576	26
35	0.01018	0.99995	0.01018	98.218	1.0000	98.223	0.02763	0.99962	0.02764	36.177	1.0004	36.191	25
36	.01047	.99994	.01047	95.489	.0000	95.495	.02792	.99961	.02793	35.800	.0004	35.814	24
37	.01076	.99994	.01076	92.908	.0000	92.914	.02821	.99960	.02822	35.431	.0004	35.445	23
38	.01105	.99994	.01105	90.463	.0001	90.469	.02850	.99959	.02851	35.069	.0004	35.084	22
39	.01134	.99993	.01134	88.143	.0001	88.149	.02879	.99958	.02880	34.715	.0004	34.729	21
40	0.01163	0.99993	0.01164	85.940	1.0001	85.946	0.02908	0.99958	0.02910	34.368	1.0004	34.382	20
41	.01193	.99993	.01193	83.843	.0001	83.849	.02937	.99957	.02939	34.027	.0004	34.042	19
42	.01222	.99992	.01222	81.847	.0001	81.853	.02967	.99956	.02968	33.693	.0004	33.708	18
43	.01251	.99992	.01251	79.943	.0001	79.950	.02996	.99955	.02997	33.366	.0004	33.381	17
44	.01280	.99992	.01280	78.126	.0001	78.133	.03025	.99954	.03026	33.045	.0004	33.060	16
45	0.01309	0.99991	0.01309	76.390	1.0001	76.396	0.03054	0.99953	0.03055	32.730	1.0005	32.745	15
46	.01338	.99991	.01338	74.729	.0001	74.736	.03083	.99952	.03084	32.421	.0005	32.437	14
47	.01367	.99991	.01367	73.139	.0001	73.146	.03112	.99951	.03113	32.118	.0005	32.134	13
48	.01396	.99990	.01396	71.615	.0001	71.622	.03141	.99951	.03143	31.820	.0005	31.836	12
49	.01425	.99990	.01425	70.153	.0001	70.160	.03170	.99950	.03172	31.528	.0005	31.544	11
50	0.01454	0.99989	0.01454	68.750	1.0001	68.757	0.03199	0.99949	0.03201	31.241	1.0005	31.257	10
51	.01483	.99989	.01484	67.402	.0001	67.409	.03228	.99948	.03230	30.960	.0005	30.976	9
52	.01512	.99988	.01513	66.105	.0001	66.113	.03257	.99947	.03259	30.683	.0005	30.699	8
53	.01542	.99988	.01542	64.858	.0001	64.866	.03286	.99946	.03288	30.411	.0005	30.428	7
54	.01571	.99988	.01571	63.657	.0001	63.664	.03315	.99945	.03317	30.145	.0005	30.161	6
55	0.01600	0.99987	0.01600	62.499	1.0001	62.507	0.03344	0.99944	0.03346	29.882	1.0005	29.899	5
56	.01629	.99987	.01629	61.383	.0001	61.391	.03374	.99943	.03375	29.624	.0006	29.641	4
57	.01658	.99987	.01658	60.306	.0001	60.314	.03403	.99942	.03405	29.371	.0006	29.388	3
58	.01687	.99986	.01687	59.266	.0001	59.274	.03432	.99941	.03434	29.122	.0006	29.139	2
59	.01716	.99985	.01716	58.261	.0001	58.270	.03461	.99940	.03463	28.877	.0006	28.894	1
60	0.01745	0.99985	0.01745	57.290	1.0001	57.299	0.03490	0.99939	0.03492	28.636	1.0006	28.654	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
90°						89°	91°						88°

NATURAL TRIGONOMETRIC FUNCTIONS

2°						177°	3°					176°	
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.03490	0.99939	0.03492	28.636	1.0006	28.654	0.05234	0.99863	0.05241	19.081	1.0014	19.107	60
1	.03519	.99938	.03521	28.399	.0006	28.417	.05263	.99861	.05270	18.975	.0014	19.002	59
2	.03548	.99937	.03550	28.166	.0006	28.184	.05292	.99860	.05299	18.871	.0014	18.897	58
3	.03577	.99936	.03579	27.937	.0006	27.955	.05321	.99858	.05328	18.768	.0014	18.794	57
4	.03606	.99935	.03608	27.712	.0006	27.730	.05350	.99857	.05357	18.665	.0014	18.692	56
5	0.03635	0.99934	0.03638	27.490	1.0007	27.508	0.05379	0.99855	0.05387	18.564	1.0014	18.591	55
6	.03664	.99933	.03667	27.271	.0007	27.290	.05408	.99854	.05416	18.464	.0015	18.491	54
7	.03693	.99932	.03696	27.056	.0007	27.075	.05437	.99852	.05445	18.365	.0015	18.393	53
8	.03722	.99931	.03725	26.845	.0007	26.864	.05466	.99850	.05474	18.268	.0015	18.295	52
9	.03751	.99930	.03754	26.637	.0007	26.655	.05495	.99849	.05503	18.171	.0015	18.198	51
10	0.03781	0.99928	0.03783	26.432	1.0007	26.450	0.05524	0.99847	0.05532	18.075	1.0015	18.103	50
11	.03810	.99927	.03812	26.230	.0007	26.249	.05553	.99846	.05562	17.980	.0015	18.008	49
12	.03839	.99926	.03842	26.031	.0007	26.050	.05582	.99844	.05591	17.886	.0016	17.914	48
13	.03868	.99925	.03871	25.835	.0007	25.854	.05611	.99842	.05620	17.793	.0016	17.821	47
14	.03897	.99924	.03900	25.642	.0008	25.661	.05640	.99841	.05649	17.701	.0016	17.730	46
15	0.03926	0.99923	0.03929	25.452	1.0008	25.471	0.05669	0.99839	0.05678	17.610	1.0016	17.639	45
16	.03955	.99922	.03958	25.264	.0008	25.284	.05698	.99837	.05707	17.520	.0016	17.549	44
17	.03984	.99921	.03987	25.080	.0008	25.100	.05727	.99836	.05737	17.431	.0016	17.460	43
18	.04013	.99919	.04016	24.898	.0008	24.918	.05756	.99834	.05766	17.343	.0017	17.372	42
19	.04042	.99918	.04045	24.718	.0008	24.739	.05785	.99832	.05795	17.256	.0017	17.285	41
20	0.04071	0.99917	0.04075	24.542	1.0008	24.562	0.05814	0.99831	0.05824	17.169	1.0017	17.198	40
21	.04100	.99916	.04104	24.367	.0008	24.388	.05843	.99829	.05853	17.084	.0017	17.113	39
22	.04129	.99915	.04133	24.196	.0008	24.216	.05872	.99827	.05883	16.999	.0017	17.028	38
23	.04158	.99913	.04162	24.026	.0009	24.047	.05902	.99826	.05912	16.915	.0017	16.944	37
24	.04187	.99912	.04191	23.859	.0009	23.880	.05931	.99824	.05941	16.832	.0018	16.861	36
25	0.04217	0.99911	0.04220	23.694	1.0009	23.716	0.05960	0.99822	0.05970	16.750	1.0018	16.779	35
26	.04246	.99910	.04249	23.532	.0009	23.553	.05989	.99820	.05999	16.668	.0018	16.698	34
27	.04275	.99908	.04279	23.372	.0009	23.393	.06018	.99819	.06029	16.587	.0018	16.617	33
28	.04304	.99907	.04308	23.214	.0009	23.235	.06047	.99817	.06058	16.507	.0018	16.538	32
29	.04333	.99906	.04337	23.058	.0009	23.079	.06076	.99815	.06087	16.428	.0018	16.459	31
30	0.04362	0.99905	0.04366	22.904	1.0009	22.925	0.06105	0.99813	0.06116	16.350	1.0019	16.380	30
31	.04391	.99903	.04395	22.752	.0010	22.774	.06134	.99812	.06145	16.272	.0019	16.303	29
32	.04420	.99902	.04424	22.602	.0010	22.624	.06163	.99810	.06175	16.195	.0019	16.226	28
33	.04449	.99901	.04453	22.454	.0010	22.476	.06192	.99808	.06204	16.119	.0019	16.150	27
34	.04478	.99900	.04483	22.308	.0010	22.330	.06221	.99806	.06233	16.043	.0019	16.075	26
35	0.04507	0.99898	0.04512	22.164	1.0010	22.186	0.06250	0.99804	0.06262	15.969	1.0019	16.000	25
36	.04536	.99897	.04541	22.022	.0010	22.044	.06279	.99803	.06291	15.894	.0020	15.926	24
37	.04565	.99896	.04570	21.881	.0010	21.904	.06308	.99801	.06321	15.821	.0020	15.853	23
38	.04594	.99894	.04599	21.742	.0010	21.765	.06337	.99799	.06350	15.748	.0020	15.780	22
39	.04623	.99893	.04628	21.606	.0011	21.629	.06366	.99797	.06379	15.676	.0020	15.708	21
40	0.04652	0.99892	0.04657	21.470	1.0011	21.494	0.06395	0.99795	0.06408	15.605	1.0020	15.637	20
41	.04681	.99890	.04687	21.337	.0011	21.360	.06424	.99793	.06437	15.534	.0021	15.566	19
42	.04711	.99889	.04716	21.205	.0011	21.228	.06453	.99791	.06467	15.464	.0021	15.496	18
43	.04740	.99888	.04745	21.075	.0011	21.098	.06482	.99790	.06496	15.394	.0021	15.427	17
44	.04769	.99886	.04774	20.946	.0011	20.970	.06511	.99788	.06525	15.325	.0021	15.358	16
45	0.04798	0.99885	0.04803	20.819	1.0011	20.843	0.06540	0.99786	0.06554	15.257	1.0021	15.290	15
46	.04827	.99883	.04832	20.693	.0012	20.717	.06569	.99784	.06583	15.189	.0022	15.222	14
47	.04856	.99882	.04862	20.569	.0012	20.593	.06598	.99782	.06613	15.122	.0022	15.155	13
48	.04885	.99881	.04891	20.446	.0012	20.471	.06627	.99780	.06642	15.056	.0022	15.089	12
49	.04914	.99879	.04920	20.325	.0012	20.350	.06656	.99778	.06671	14.990	.0022	15.023	11
50	0.04943	0.99878	0.04949	20.205	1.0012	20.230	0.06685	0.99776	0.06700	14.924	1.0022	14.958	10
51	.04972	.99876	.04978	20.087	.0012	20.112	.06714	.99774	.06730	14.860	.0023	14.893	9
52	.05001	.99875	.05007	19.970	.0012	19.995	.06743	.99772	.06759	14.795	.0023	14.829	8
53	.05030	.99873	.05037	19.854	.0013	19.880	.06772	.99770	.06788	14.732	.0023	14.765	7
54	.05059	.99872	.05066	19.740	.0013	19.766	.06801	.99768	.06817	14.668	.0023	14.702	6
55	0.05088	0.99870	0.05095	19.627	1.0013	19.653	0.06830	0.99766	0.06846	14.606	1.0023	14.640	5
56	.05117	.99869	.05124	19.515	.0013	19.541	.06859	.99764	.06876	14.544	.0024	14.578	4
57	.05146	.99867	.05153	19.405	.0013	19.431	.06888	.99762	.06905	14.482	.0024	14.517	3
58	.05175	.99866	.05182	19.296	.0013	19.322	.06918	.99760	.06934	14.421	.0024	14.456	2
59	.05204	.99864	.05212	19.188	.0013	19.214	.06947	.99758	.06963	14.361	.0024	14.395	1
60	0.05234	0.99863	0.05241	19.081	1.0014	19.107	0.06976	0.99756	0.06993	14.301	1.0024	14.335	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
92°						87°	93°					86°	

NATURAL TRIGONOMETRIC FUNCTIONS

4°						175°	5°						174°
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.06976	0.99756	0.06993	14.301	1.0024	14.335	0.08715	0.99619	0.08749	11.430	1.0038	11.474	60
1	.07005	.99754	.07022	14.241	.0025	14.276	.08744	.99617	.08778	11.392	.0038	11.436	59
2	.07034	.99752	.07051	14.182	.0025	14.217	.08773	.99614	.08807	11.354	.0039	11.398	58
3	.07063	.99750	.07080	14.123	.0025	14.159	.08802	.99612	.08837	11.316	.0039	11.360	57
4	.07092	.99748	.07110	14.065	.0025	14.101	.08831	.99609	.08866	11.279	.0039	11.323	56
5	0.07121	0.99746	0.07139	14.008	1.0025	14.043	0.08860	0.99607	0.08895	11.242	1.0039	11.286	55
6	.07150	.99744	.07168	13.951	.0026	13.986	.08889	.99604	.08925	11.205	.0040	11.249	54
7	.07179	.99742	.07197	13.894	.0026	13.930	.08918	.99601	.08954	11.168	.0040	11.213	53
8	.07208	.99740	.07226	13.838	.0026	13.874	.08947	.99599	.08983	11.132	.0040	11.176	52
9	.07237	.99738	.07256	13.782	.0026	13.818	.08976	.99596	.09013	11.095	.0040	11.140	51
10	0.07266	0.99736	0.07285	13.727	1.0026	13.763	0.09005	0.99594	0.09042	11.059	1.0041	11.104	50
11	.07295	.99733	.07314	13.672	.0027	13.708	.09034	.99591	.09071	11.024	.0041	11.069	49
12	.07324	.99731	.07343	13.617	.0027	13.654	.09063	.99588	.09101	10.988	.0041	11.033	48
13	.07353	.99729	.07373	13.563	.0027	13.600	.09092	.99586	.09130	10.953	.0041	10.998	47
14	.07382	.99727	.07402	13.510	.0027	13.547	.09121	.99583	.09159	10.918	.0042	10.963	46
15	0.07411	0.99725	0.07431	13.457	1.0027	13.494	0.09150	0.99580	0.09189	10.883	1.0042	10.929	45
16	.07440	.99723	.07460	13.404	.0028	13.441	.09179	.99578	.09218	10.848	.0042	10.894	44
17	.07469	.99721	.07490	13.351	.0028	13.389	.09208	.99575	.09247	10.814	.0043	10.860	43
18	.07498	.99718	.07519	13.299	.0028	13.337	.09237	.99572	.09277	10.780	.0043	10.826	42
19	.07527	.99716	.07548	13.248	.0028	13.286	.09266	.99570	.09306	10.746	.0043	10.792	41
20	0.07556	0.99714	0.07577	13.197	1.0029	13.235	0.09295	0.99567	0.09335	10.712	1.0043	10.758	40
21	.07585	.99712	.07607	13.146	.0029	13.184	.09324	.99564	.09365	10.678	.0044	10.725	39
22	.07614	.99710	.07636	13.096	.0029	13.134	.09353	.99562	.09394	10.645	.0044	10.692	38
23	.07643	.99707	.07665	13.046	.0029	13.084	.09382	.99559	.09423	10.612	.0044	10.659	37
24	.07672	.99705	.07694	12.996	.0029	13.034	.09411	.99556	.09453	10.579	.0044	10.626	36
25	0.07701	0.99703	0.07724	12.947	1.0030	12.985	0.09440	0.99553	0.09482	10.546	1.0045	10.593	35
26	.07730	.99701	.07753	12.898	.0030	12.937	.09469	.99551	.09511	10.514	.0045	10.561	34
27	.07759	.99698	.07782	12.849	.0030	12.888	.09498	.99548	.09541	10.481	.0045	10.529	33
28	.07788	.99696	.07812	12.801	.0030	12.840	.09527	.99545	.09570	10.449	.0046	10.497	32
29	.07817	.99694	.07841	12.754	.0031	12.793	.09556	.99542	.09599	10.417	.0046	10.465	31
30	0.07846	0.99692	0.07870	12.706	1.0031	12.745	0.09584	0.99540	0.09629	10.385	1.0046	10.433	30
31	.07875	.99689	.07899	12.659	.0031	12.698	.09613	.99537	.09658	10.354	.0046	10.402	29
32	.07904	.99687	.07929	12.612	.0031	12.652	.09642	.99534	.09688	10.322	.0047	10.371	28
33	.07933	.99685	.07958	12.566	.0032	12.606	.09671	.99531	.09717	10.291	.0047	10.340	27
34	.07962	.99682	.07987	12.520	.0032	12.560	.09700	.99528	.09746	10.260	.0047	10.309	26
35	0.07991	0.99680	0.08016	12.474	1.0032	12.514	0.09729	0.99525	0.09776	10.229	1.0048	10.278	25
36	.08020	.99678	.08046	12.429	.0032	12.469	.09758	.99523	.09805	10.199	.0048	10.248	24
37	.08049	.99675	.08075	12.384	.0032	12.424	.09787	.99520	.09834	10.168	.0048	10.217	23
38	.08078	.99673	.08104	12.339	.0033	12.379	.09816	.99517	.09864	10.138	.0048	10.187	22
39	.08107	.99671	.08134	12.295	.0033	12.335	.09845	.99514	.09893	10.108	.0049	10.157	21
40	0.08136	0.99668	0.08163	12.250	1.0033	12.291	0.09874	0.99511	0.09922	10.078	1.0049	10.127	20
41	.08165	.99666	.08192	12.207	.0033	12.248	.09903	.99508	.09952	10.048	.0049	10.098	19
42	.08194	.99664	.08221	12.163	.0034	12.204	.09932	.99505	.09981	10.019	.0050	10.068	18
43	.08223	.99661	.08251	12.120	.0034	12.161	.09961	.99503	.10011	9.9893	.0050	10.039	17
44	.08252	.99659	.08280	12.077	.0034	12.118	.09990	.99500	.10040	9.9601	.0050	10.010	16
45	0.08281	0.99656	0.08309	12.035	1.0034	12.076	0.10019	0.99497	0.10069	9.9310	1.0050	9.9812	15
46	.08310	.99654	.08339	11.992	.0035	12.034	.10048	.99494	.10099	9.9021	.0051	9.9525	14
47	.08339	.99652	.08368	11.950	.0035	11.992	.10077	.99491	.10128	9.8734	.0051	9.9239	13
48	.08368	.99649	.08397	11.909	.0035	11.950	.10106	.99488	.10158	9.8448	.0051	9.8955	12
49	.08397	.99647	.08426	11.867	.0035	11.909	.10134	.99485	.10187	9.8164	.0052	9.8672	11
50	0.08426	0.99644	0.08456	11.826	1.0036	11.868	0.10163	0.99482	0.10216	9.7882	1.0052	9.8391	10
51	.08455	.99642	.08485	11.785	.0036	11.828	.10192	.99479	.10246	9.7601	.0052	9.8112	9
52	.08484	.99639	.08514	11.745	.0036	11.787	.10221	.99476	.10275	9.7322	.0053	9.7834	8
53	.08513	.99637	.08544	11.704	.0036	11.747	.10250	.99473	.10305	9.7044	.0053	9.7558	7
54	.08542	.99634	.08573	11.664	.0037	11.707	.10279	.99470	.10334	9.6768	.0053	9.7283	6
55	0.08571	0.99632	0.08602	11.625	1.0037	11.668	0.10308	0.99467	0.10363	9.6493	1.0053	9.7010	5
56	.08600	.99629	.08632	11.585	.0037	11.628	.10337	.99464	.10393	9.6220	.0054	9.6739	4
57	.08629	.99627	.08661	11.546	.0037	11.589	.10366	.99461	.10422	9.5949	.0054	9.6469	3
58	.08658	.99624	.08690	11.507	.0038	11.550	.10395	.99458	.10452	9.5679	.0054	9.6200	2
59	.08687	.99622	.08719	11.468	.0038	11.512	.10424	.99455	.10481	9.5411	.0055	9.5933	1
60	0.08715	0.99619	0.08749	11.430	1.0038	11.474	0.10453	0.99452	0.10510	9.5144	1.0055	9.5668	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
94°						85°	95°						84°

NATURAL TRIGONOMETRIC FUNCTIONS

6°						173°	7°						172°
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0 10453	0.99452	0.10510	9.5144	1.0055	9.5668	0.12187	0.99255	0.12278	8.1443	1.0075	8.2055	60
1	.10482	.99449	.10540	.4878	.0055	.5404	.12216	.99251	.12308	.1248	.0075	.1861	59
2	.10511	.99446	.10569	.4614	.0056	.5141	.12245	.99247	.12337	.1053	.0076	.1668	58
3	.10540	.99443	.10599	.4351	.0056	.4880	.12273	.99244	.12367	.0860	.0076	.1476	57
4	.10568	.99440	.10628	.4090	.0056	.4620	.12302	.99240	.12396	.0667	.0076	.1285	56
5	0.10597	0.99437	0.10657	9.3831	1.0057	9.4362	0.12331	0.99237	0.12426	8.0476	1.0077	8.1094	55
6	.10626	.99434	.10687	.3572	.0057	.4105	.12360	.99233	.12456	.0285	.0077	.0905	54
7	.10655	.99431	.10716	.3315	.0057	.3850	.12389	.99229	.12485	.0095	.0078	.0717	53
8	.10684	.99428	.10746	.3060	.0057	.3596	.12418	.99226	.12515	7.9906	.0078	.0529	52
9	.10713	.99424	.10775	.2806	.0058	.3343	.12447	.99222	.12544	.9717	.0078	.0342	51
10	0.10742	0.99421	0.10805	9.2553	1.0058	9.3092	0.12476	0.99219	0.12574	7.9530	1.0079	8.0156	50
11	.10771	.99418	.10834	.2302	.0058	.2842	.12504	.99215	.12603	.9344	.0079	7.9971	49
12	.10800	.99415	.10863	.2051	.0059	.2593	.12533	.99211	.12633	.9158	.0079	.9787	48
13	.10829	.99412	.10893	.1803	.0059	.2346	.12562	.99208	.12662	.8973	.0080	.9604	47
14	.10858	.99409	.10922	.1555	.0059	.2100	.12591	.99204	.12692	.8789	.0080	.9421	46
15	0.10887	0.99406	0.10952	9.1309	1.0060	9.1855	0.12620	0.99200	0.12722	7.8606	1.0080	7.9240	45
16	.10916	.99402	.10981	.1064	.0060	.1612	.12649	.99197	.12751	.8424	.0081	.9059	44
17	.10944	.99399	.11011	.0821	.0060	.1370	.12678	.99193	.12781	.8243	.0081	.8879	43
18	.10973	.99396	.11040	.0579	.0061	.1129	.12706	.99189	.12810	.8062	.0082	.8700	42
19	.11002	.99393	.11069	.0338	.0061	.0890	.12735	.99186	.12840	.7882	.0082	.8522	41
20	0.11031	0.99390	0.11099	9.0098	1.0061	9.0651	0.12764	0.99182	0.12869	7.7703	1.0082	7.8344	40
21	.11060	.99386	.11128	8.9860	.0062	.0414	.12793	.99178	.12899	.7525	.0083	.8168	39
22	.11089	.99383	.11158	.9623	.0062	.0179	.12822	.99174	.12928	.7348	.0083	.7992	38
23	.11118	.99380	.11187	.9387	.0062	8.9944	.12851	.99171	.12958	.7171	.0084	.7817	37
24	.11147	.99377	.11217	.9152	.0063	.9711	.12879	.99167	.12988	.6996	.0084	.7642	36
25	0.11176	0.99373	0.11246	8.8918	1.0063	8.9479	0.12908	0.99163	0.13017	7.6821	1.0084	7.7469	35
26	.11205	.99370	.11276	.8686	.0063	.9248	.12937	.99160	.13047	.6646	.0085	.7296	34
27	.11234	.99367	.11305	.8455	.0064	.9018	.12966	.99156	.13076	.6473	.0085	.7124	33
28	.11262	.99364	.11335	.8225	.0064	.8790	.12995	.99152	.13106	.6300	.0085	.6953	32
29	.11291	.99360	.11364	.7996	.0064	.8563	.13024	.99148	.13136	.6129	.0086	.6783	31
30	0.11320	0.99357	0.11393	8.7769	1.0065	8.8337	0.13053	0.99144	0.13165	7.5957	1.0086	7.6613	30
31	.11349	.99354	.11423	.7542	.0065	.8112	.13081	.99141	.13195	.5787	.0087	.6444	29
32	.11378	.99350	.11452	.7317	.0065	.7888	.13110	.99137	.13224	.5617	.0087	.6276	28
33	.11407	.99347	.11482	.7093	.0066	.7665	.13139	.99133	.13254	.5449	.0087	.6108	27
34	.11436	.99344	.11511	.6870	.0066	.7444	.13168	.99129	.13284	.5280	.0088	.5942	26
35	0.11465	0.99341	0.11541	8.6648	1.0066	8.7223	0.13197	0.99125	0.13313	7.5113	1.0088	7.5776	25
36	.11494	.99337	.11570	.6427	.0067	.7004	.13226	.99121	.13343	.4946	.0089	.5611	24
37	.11523	.99334	.11600	.6208	.0067	.6786	.13254	.99118	.13372	.4780	.0089	.5446	23
38	.11551	.99330	.11629	.5989	.0067	.6569	.13283	.99114	.13402	.4615	.0089	.5282	22
39	.11580	.99327	.11659	.5772	.0068	.6353	.13312	.99110	.13432	.4451	.0090	.5119	21
40	0.11609	0.99324	0.11688	8.5555	1.0068	8.6138	0.13341	0.99106	0.13461	7.4287	1.0090	7.4957	20
41	.11638	.99320	.11718	.5340	.0068	.5924	.13370	.99102	.13491	.4124	.0090	.4795	19
42	.11667	.99317	.11747	.5126	.0069	.5711	.13399	.99098	.13520	.3961	.0091	.4634	18
43	.11696	.99314	.11777	.4913	.0069	.5499	.13427	.99094	.13550	.3800	.0091	.4474	17
44	.11725	.99310	.11806	.4701	.0069	.5289	.13456	.99090	.13580	.3639	.0092	.4315	16
45	0.11754	0.99307	0.11836	8.4489	1.0070	8.5079	0.13485	0.99086	0.13609	7.3479	1.0092	7.4156	15
46	.11783	.99303	.11865	.4279	.0070	.4871	.13514	.99083	.13639	.3319	.0092	.3998	14
47	.11811	.99300	.11895	.4070	.0070	.4663	.13543	.99079	.13669	.3160	.0093	.3840	13
48	.11840	.99296	.11924	.3862	.0071	.4457	.13571	.99075	.13698	.3002	.0093	.3683	12
49	.11869	.99293	.11954	.3655	.0071	.4251	.13600	.99071	.13728	.2844	.0094	.3527	11
50	0.11898	0.99290	0.11983	8.3449	1.0071	8.4046	0.13629	0.99067	0.13757	7.2687	1.0094	7.3372	10
51	.11927	.99286	.12013	.3244	.0072	.3843	.13658	.99063	.13787	.2531	.0094	.3217	9
52	.11956	.99283	.12042	.3040	.0072	.3640	.13687	.99059	.13817	.2375	.0095	.3063	8
53	.11985	.99279	.12072	.2837	.0073	.3439	.13716	.99055	.13846	.2220	.0095	.2909	7
54	.12014	.99276	.12101	.2635	.0073	.3238	.13744	.99051	.13876	.2066	.0096	.2757	6
55	0.12042	0.99272	0.12131	8.2434	1.0073	8.3039	0.13773	0.99047	0.13906	7.1912	1.0096	7.2604	5
56	.12071	.99269	.12160	.2234	.0074	.2840	.13802	.99043	.13935	.1759	.0097	.2453	4
57	.12100	.99265	.12190	.2035	.0074	.2642	.13831	.99039	.13965	.1607	.0097	.2302	3
58	.12129	.99262	.12219	.1837	.0074	.2446	.13860	.99035	.13995	.1455	.0097	.2152	2
59	.12158	.99258	.12249	.1640	.0075	.2250	.13888	.99031	.14024	.1304	.0098	.2002	1
60	0.12187	0.99255	0.12278	8.1443	1.0075	8.2055	0.13917	0.99027	0.14054	7.1154	1.0098	7.1853	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
96°						83°	97°						82°

NATURAL TRIGONOMETRIC FUNCTIONS

8°						171°	9°						170°
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.13917	0.99027	0.14054	7.1154	1.0098	7.1853	0.15643	0.98769	0.15838	6.3137	1.0125	6.3924	60
1	.13946	.99023	.14084	.1004	.0099	.1704	.15672	.98764	.15868	.3019	.0125	.3807	59
2	.13975	.99019	.14113	.0854	.0099	.1557	.15701	.98760	.15898	.2901	.0125	.3690	58
3	.14004	.99015	.14143	.0706	.0099	.1409	.15730	.98755	.15928	.2783	.0126	.3574	57
4	.14032	.99010	.14173	.0558	.0100	.1263	.15758	.98750	.15958	.2665	.0126	.3458	56
5	0.14061	0.99006	0.14202	7.0410	1.0100	7.1117	0.15787	0.98746	0.15987	6.2548	1.0127	6.3343	55
6	.14090	.99002	.14232	.0264	.0101	.0972	.15816	.98741	.16017	.2432	.0127	.3228	54
7	.14119	.98998	.14262	.0117	.0101	.0827	.15844	.98737	.16047	.2316	.0128	.3113	53
8	.14148	.98994	.14291	6.9972	.0102	.0683	.15873	.98732	.16077	.2200	.0128	.2999	52
9	.14176	.98990	.14321	.9827	.0102	.0539	.15902	.98727	.16107	.2085	.0129	.2885	51
10	0.14205	0.98986	0.14351	6.9682	1.0102	7.0396	0.15931	0.98723	0.16137	6.1970	1.0129	6.2772	50
11	.14234	.98982	.14380	.9538	.0103	.0254	.15959	.98718	.16167	.1856	.0130	.2659	49
12	.14263	.98978	.14410	.9395	.0103	.0112	.15988	.98714	.16196	.1742	.0130	.2546	48
13	.14292	.98973	.14440	.9252	.0104	6.9971	.16017	.98709	.16226	.1628	.0131	.2434	47
14	.14320	.98969	.14470	.9110	.0104	.9830	.16045	.98704	.16256	.1515	.0131	.2322	46
15	0.14349	0.98965	0.14499	6.8969	1.0104	6.9690	0.16074	0.98700	0.16286	6.1402	1.0132	6.2211	45
16	.14378	.98961	.14529	.8828	.0105	.9550	.16103	.98695	.16316	.1290	.0132	.2100	44
17	.14407	.98957	.14559	.8687	.0105	.9411	.16132	.98690	.16346	.1178	.0133	.1990	43
18	.14436	.98952	.14588	.8547	.0106	.9273	.16160	.98685	.16376	.1066	.0133	.1880	42
19	.14464	.98948	.14618	.8408	.0106	.9135	.16189	.98681	.16405	.0955	.0134	.1770	41
20	0.14493	0.98944	0.14648	6.8269	1.0107	6.8998	0.16218	0.98676	0.16435	6.0844	1.0134	6.1661	40
21	.14522	.98940	.14677	.8131	.0107	.8861	.16246	.98671	.16465	.0734	.0135	.1552	39
22	.14551	.98936	.14707	.7993	.0107	.8725	.16275	.98667	.16495	.0624	.0135	.1443	38
23	.14579	.98931	.14737	.7856	.0108	.8589	.16304	.98662	.16525	.0514	.0136	.1335	37
24	.14608	.98927	.14767	.7720	.0108	.8454	.16333	.98657	.16555	.0405	.0136	.1227	36
25	0.14637	0.98923	0.14796	6.7584	1.0109	6.8320	0.16361	0.98652	0.16585	6.0296	1.0136	6.1120	35
26	.14666	.98919	.14826	.7448	.0109	.8185	.16390	.98648	.16615	.0188	.0137	.1013	34
27	.14695	.98914	.14856	.7313	.0110	.8052	.16419	.98643	.16644	.0080	.0137	.0906	33
28	.14723	.98910	.14886	.7179	.0110	.7919	.16447	.98638	.16674	5.9972	.0138	.0800	32
29	.14752	.98906	.14915	.7045	.0111	.7787	.16476	.98633	.16704	.9865	.0138	.0694	31
30	0.14781	0.98901	0.14945	6.6911	1.0111	6.7655	0.16505	0.98628	0.16734	5.9758	1.0139	6.0588	30
31	.14810	.98897	.14975	.6779	.0111	.7523	.16533	.98624	.16764	.9651	.0139	.0483	29
32	.14838	.98893	.15004	.6646	.0112	.7392	.16562	.98619	.16794	.9545	.0140	.0379	28
33	.14867	.98889	.15034	.6514	.0112	.7262	.16591	.98614	.16824	.9439	.0140	.0274	27
34	.14896	.98884	.15064	.6383	.0113	.7132	.16619	.98609	.16854	.9333	.0141	.0170	26
35	0.14925	0.98880	0.15094	6.6252	1.0113	6.7003	0.16648	0.98604	0.16884	5.9228	1.0141	6.0066	25
36	.14953	.98876	.15123	.6122	.0114	.6874	.16677	.98600	.16914	.9123	.0142	5.9963	24
37	.14982	.98871	.15153	.5992	.0114	.6745	.16705	.98595	.16944	.9019	.0142	.9860	23
38	.15011	.98867	.15183	.5863	.0115	.6617	.16734	.98590	.16973	.8915	.0143	.9758	22
39	.15040	.98862	.15213	.5734	.0115	.6490	.16763	.98585	.17003	.8811	.0143	.9655	21
40	0.15068	0.98858	0.15243	6.5605	1.0115	6.6363	0.16791	0.98580	0.17033	5.8708	1.0144	5.9554	20
41	.15097	.98854	.15272	.5478	.0116	.6237	.16820	.98575	.17063	.8605	.0144	.9452	19
42	.15126	.98849	.15302	.5350	.0116	.6111	.16849	.98570	.17093	.8502	.0145	.9351	18
43	.15155	.98845	.15332	.5223	.0117	.5985	.16878	.98565	.17123	.8400	.0145	.9250	17
44	.15183	.98840	.15362	.5097	.0117	.5860	.16906	.98560	.17153	.8298	.0146	.9150	16
45	0.15212	0.98836	0.15391	6.4971	1.0118	6.5736	0.16935	0.98556	0.17183	5.8196	1.0146	5.9049	15
46	.15241	.98832	.15421	.4845	.0118	.5612	.16964	.98551	.17213	.8095	.0147	.8950	14
47	.15270	.98827	.15451	.4720	.0119	.5488	.16992	.98546	.17243	.7994	.0147	.8850	13
48	.15298	.98823	.15481	.4596	.0119	.5365	.17021	.98541	.17273	.7894	.0148	.8751	12
49	.15328	.98818	.15511	.4472	.0119	.5243	.17050	.98536	.17303	.7794	.0148	.8652	11
50	0.15356	0.98814	0.15540	6.4348	1.0120	6.5121	0.17078	0.98531	0.17333	5.7694	1.0149	5.8554	10
51	.15385	.98809	.15570	.4225	.0120	.4999	.17107	.98526	.17363	.7594	.0150	.8456	9
52	.15413	.98805	.15600	.4103	.0121	.4878	.17136	.98521	.17393	.7495	.0150	.8358	8
53	.15442	.98800	.15630	.3980	.0121	.4757	.17164	.98516	.17423	.7396	.0151	.8261	7
54	.15471	.98796	.15659	.3859	.0122	.4637	.17193	.98511	.17453	.7297	.0151	.8163	6
55	0.15500	0.98791	0.15689	6.3737	1.0122	6.4517	0.17221	0.98506	0.17483	5.7199	1.0152	5.8067	5
56	.15528	.98787	.15719	.3616	.0123	.4398	.17250	.98501	.17513	.7101	.0152	.7970	4
57	.15557	.98782	.15749	.3496	.0123	.4279	.17279	.98496	.17543	.7004	.0153	.7874	3
58	.15586	.98778	.15779	.3376	.0124	.4160	.17307	.98491	.17573	.6906	.0153	.7778	2
59	.15615	.98773	.15809	.3257	.0124	.4042	.17336	.98486	.17603	.6809	.0154	.7683	1
60	0.15643	0.98769	0.15838	6.3137	1.0125	6.3924	0.17365	0.98481	0.17633	5.6713	1.0154	5.7588	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
98°						81°	99°						80°

NATURAL TRIGONOMETRIC FUNCTIONS

10°						169°	11°						168°
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.17365	0.98481	0.17633	5.6713	1.0154	5.7588	0.19081	0.98163	0.19438	5.1445	1.0187	5.2408	60
1	.17393	.98476	.17663	.6616	.0155	.7493	.19109	.98157	.19468	.1366	.0188	.2330	59
2	.17422	.98471	.17693	.6520	.0155	.7398	.19138	.98152	.19498	.1286	.0188	.2252	58
3	.17451	.98465	.17723	.6425	.0156	.7304	.19166	.98146	.19529	.1207	.0189	.2174	57
4	.17479	.98460	.17753	.6329	.0156	.7210	.19195	.98140	.19559	.1128	.0189	.2097	56
5	0.17508	0.98455	0.17783	5.6234	1.0157	5.7117	0.19224	0.98135	0.19589	5.1049	1.0190	5.2019	55
6	.17537	.98450	.17813	.6140	.0157	.7023	.19252	.98129	.19619	.0970	.0191	.1942	54
7	.17565	.98445	.17843	.6045	.0158	.6930	.19281	.98124	.19649	.0892	.0191	.1865	53
8	.17594	.98440	.17873	.5951	.0158	.6838	.19309	.98118	.19680	.0814	.0192	.1788	52
9	.17622	.98435	.17903	.5857	.0159	.6745	.19338	.98112	.19710	.0736	.0192	.1712	51
10	0.17651	0.98430	0.17933	5.5764	1.0159	5.6653	0.19366	0.98107	0.19740	5.0658	1.0193	5.1636	50
11	.17680	.98425	.17963	.5670	.0160	.6561	.19395	.98101	.19770	.0581	.0193	.1560	49
12	.17708	.98419	.17993	.5578	.0160	.6470	.19423	.98095	.19800	.0504	.0194	.1484	48
13	.17737	.98414	.18023	.5485	.0161	.6379	.19452	.98090	.19831	.0427	.0195	.1409	47
14	.17766	.98409	.18053	.5393	.0162	.6288	.19480	.98084	.19861	.0350	.0195	.1333	46
15	0.17794	0.98404	0.18083	5.5301	1.0162	5.6197	0.19509	0.98078	0.19891	5.0273	1.0196	5.1258	45
16	.17823	.98399	.18113	.5209	.0163	.6107	.19537	.98073	.19921	.0197	.0196	.1183	44
17	.17852	.98394	.18143	.5117	.0163	.6017	.19566	.98067	.19952	.0121	.0197	.1109	43
18	.17880	.98388	.18173	.5026	.0164	.5928	.19595	.98061	.19982	.0045	.0198	.1034	42
19	.17909	.98383	.18203	.4936	.0164	.5838	.19623	.98056	.20012	4.9969	.0198	.0960	41
20	0.17937	0.98378	0.18233	5.4845	1.0165	5.5749	0.19652	0.98050	0.20042	4.9894	1.0199	5.0886	40
21	.17966	.98373	.18263	.4755	.0165	.5660	.19680	.98044	.20073	.9819	.0199	.0812	39
22	.17995	.98368	.18293	.4665	.0166	.5572	.19709	.98039	.20103	.9744	.0200	.0739	38
23	.18023	.98362	.18323	.4575	.0166	.5484	.19737	.98033	.20133	.9669	.0201	.0666	37
24	.18052	.98357	.18353	.4486	.0167	.5396	.19766	.98027	.20163	.9594	.0201	.0593	36
25	0.18080	0.98352	0.18383	5.4396	1.0167	5.5308	0.19794	0.98021	0.20194	4.9520	1.0202	5.0520	35
26	.18109	.98347	.18413	.4308	.0168	.5221	.19823	.98016	.20224	.9446	.0202	.0447	34
27	.18138	.98341	.18444	.4219	.0169	.5134	.19851	.98010	.20254	.9372	.0203	.0375	33
28	.18166	.98336	.18474	.4131	.0169	.5047	.19880	.98004	.20285	.9298	.0204	.0302	32
29	.18195	.98331	.18504	.4043	.0170	.4960	.19908	.97998	.20315	.9225	.0204	.0230	31
30	0.18223	0.98325	0.18534	5.3955	1.0170	5.4874	0.19937	0.97992	0.20345	4.9151	1.0205	5.0158	30
31	.18252	.98320	.18564	.3868	.0171	.4788	.19965	.97987	.20375	.9078	.0205	.0087	29
32	.18281	.98315	.18594	.3780	.0171	.4702	.19994	.97981	.20406	.9006	.0206	.0015	28
33	.18309	.98309	.18624	.3694	.0172	.4617	.20022	.97975	.20436	.8933	.0207	4.9944	27
34	.18338	.98304	.18654	.3607	.0172	.4532	.20051	.97969	.20466	.8860	.0207	.9873	26
35	0.18366	0.98299	0.18684	5.3521	1.0173	5.4447	0.20079	0.97963	0.20497	4.8788	1.0208	4.9802	25
36	.18395	.98293	.18714	.3434	.0174	.4362	.20108	.97957	.20527	.8716	.0208	.9732	24
37	.18424	.98288	.18745	.3349	.0174	.4278	.20136	.97952	.20557	.8644	.0209	.9661	23
38	.18452	.98283	.18775	.3263	.0175	.4194	.20165	.97946	.20588	.8573	.0210	.9591	22
39	.18481	.98277	.18805	.3178	.0175	.4110	.20193	.97940	.20618	.8501	.0210	.9521	21
40	0.18509	0.98272	0.18835	5.3093	1.0176	5.4026	0.20222	0.97934	0.20648	4.8430	1.0211	4.9452	20
41	.18538	.98267	.18865	.3008	.0176	.3943	.20250	.97928	.20679	.8359	.0211	.9382	19
42	.18567	.98261	.18895	.2923	.0177	.3860	.20279	.97922	.20709	.8288	.0212	.9313	18
43	.18595	.98256	.18925	.2839	.0177	.3777	.20307	.97916	.20739	.8217	.0213	.9243	17
44	.18624	.98250	.18955	.2755	.0178	.3695	.20336	.97910	.20770	.8147	.0213	.9175	16
45	0.18652	0.98245	0.18985	5.2671	1.0179	5.3612	0.20364	0.97904	0.20800	4.8077	1.0214	4.9106	15
46	.18681	.98240	.19016	.2588	.0179	.3530	.20393	.97899	.20830	.8007	.0215	.9037	14
47	.18709	.98234	.19046	.2505	.0180	.3449	.20421	.97893	.20861	.7937	.0215	.8969	13
48	.18738	.98229	.19076	.2422	.0180	.3367	.20450	.97887	.20891	.7867	.0216	.8901	12
49	.18767	.98223	.19106	.2339	.0181	.3286	.20478	.97881	.20921	.7798	.0216	.8833	11
50	0.18795	0.98218	0.19136	5.2257	1.0181	5.3205	0.20506	0.97875	0.20952	4.7728	1.0217	4.8765	10
51	.18824	.98212	.19166	.2174	.0182	.3124	.20535	.97869	.20982	.7659	.0218	.8697	9
52	.18852	.98207	.19197	.2092	.0182	.3044	.20563	.97863	.21012	.7591	.0218	.8630	8
53	.18881	.98201	.19227	.2011	.0183	.2963	.20592	.97857	.21043	.7522	.0219	.8563	7
54	.18909	.98196	.19257	.1929	.0184	.2883	.20620	.97851	.21073	.7453	.0220	.8496	6
55	0.18938	0.98190	0.19287	5.1848	1.0184	5.2803	0.20649	0.97845	0.21104	4.7385	1.0220	4.8429	5
56	.18967	.98185	.19317	.1767	.0185	.2724	.20677	.97839	.21134	.7317	.0221	.8362	4
57	.18995	.98179	.19347	.1686	.0185	.2645	.20706	.97833	.21164	.7249	.0221	.8296	3
58	.19024	.98174	.19378	.1606	.0186	.2566	.20734	.97827	.21195	.7181	.0222	.8229	2
59	.19052	.98168	.19408	.1525	.0186	.2487	.20763	.97821	.21225	.7114	.0223	.8163	1
60	0.19081	0.98163	0.19438	5.1445	1.0187	5.2408	0.20791	0.97815	0.21256	4.7046	1.0223	4.8097	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
100°						79°	101°						78°

NATURAL TRIGONOMETRIC FUNCTIONS

	12°					167°	13°					166°	
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.20791	0.97815	0.21256	4.7046	1.0223	4.8097	0.22495	0.97437	0.23087	4.3315	1.0263	4.4454	60
1	.20820	.97809	.21286	.6979	.0224	.8032	.22523	.97430	.23117	.3257	.0264	.4398	59
2	.20848	.97803	.21316	.6912	.0225	.7966	.22552	.97424	.23148	.3200	.0264	.4342	58
3	.20876	.97797	.21347	.6845	.0225	.7901	.22580	.97417	.23179	.3143	.0265	.4287	57
4	.20905	.97790	.21377	.6778	.0226	.7835	.22608	.97411	.23209	.3086	.0266	.4231	56
5	0.20933	0.97784	0.21408	4.6712	1.0226	4.7770	0.22637	0.97404	0.23240	4.3029	1.0266	4.4176	55
6	.20962	.97778	.21438	.6646	.0227	.7706	.22665	.97398	.23270	.2972	.0267	.4121	54
7	.20990	.97772	.21468	.6580	.0228	.7641	.22693	.97391	.23301	.2916	.0268	.4065	53
8	.21019	.97766	.21499	.6514	.0228	.7576	.22722	.97384	.23332	.2859	.0268	.4011	52
9	.21047	.97760	.21529	.6448	.0229	.7512	.22750	.97378	.23363	.2803	.0269	.3956	51
10	0.21076	0.97754	0.21560	4.6382	1.0230	4.7448	0.22778	0.97371	0.23393	4.2747	1.0270	4.3901	50
11	.21104	.97748	.21590	.6317	.0230	.7384	.22807	.97364	.23424	.2691	.0271	.3847	49
12	.21132	.97741	.21621	.6252	.0231	.7320	.22835	.97358	.23455	.2635	.0271	.3792	48
13	.21161	.97735	.21651	.6187	.0232	.7257	.22863	.97351	.23485	.2579	.0272	.3738	47
14	.21189	.97729	.21682	.6122	.0232	.7193	.22892	.97344	.23516	.2524	.0273	.3684	46
15	0.21218	0.97723	0.21712	4.6057	1.0233	4.7130	0.22920	0.97338	0.23547	4.2468	1.0273	4.3630	45
16	.21246	.97717	.21742	.5993	.0234	.7067	.22948	.97331	.23577	.2413	.0274	.3576	44
17	.21275	.97711	.21773	.5928	.0234	.7004	.22977	.97324	.23608	.2358	.0275	.3522	43
18	.21303	.97704	.21803	.5864	.0235	.6942	.23005	.97318	.23639	.2303	.0276	.3469	42
19	.21331	.97698	.21834	.5800	.0235	.6879	.23033	.97311	.23670	.2248	.0276	.3415	41
20	0.21360	0.97692	0.21864	4.5736	1.0236	4.6817	0.23061	0.97304	0.23700	4.2193	1.0277	4.3362	40
21	.21388	.97686	.21895	.5673	.0237	.6754	.23090	.97298	.23731	.2139	.0278	.3309	39
22	.21417	.97680	.21925	.5609	.0237	.6692	.23118	.97291	.23762	.2084	.0278	.3256	38
23	.21445	.97673	.21956	.5546	.0238	.6631	.23146	.97284	.23793	.2030	.0279	.3203	37
24	.21473	.97667	.21986	.5483	.0239	.6569	.23175	.97277	.23823	.1976	.0280	.3150	36
25	0.21502	0.97661	0.22017	4.5420	1.0239	4.6507	0.23203	0.97271	0.23854	4.1921	1.0280	4.3098	35
26	.21530	.97655	.22047	.5357	.0240	.6446	.23231	.97264	.23885	.1867	.0281	.3045	34
27	.21559	.97648	.22078	.5294	.0241	.6385	.23260	.97257	.23916	.1814	.0282	.2993	33
28	.21587	.97642	.22108	.5232	.0241	.6324	.23288	.97250	.23946	.1760	.0283	.2941	32
29	.21615	.97636	.22139	.5169	.0242	.6263	.23316	.97244	.23977	.1706	.0283	.2838	31
30	0.21644	0.97630	0.22169	4.5107	1.0243	4.6201	0.23344	0.97237	0.24008	4.1653	1.0284	4.2836	30
31	.21672	.97623	.22200	.5045	.0243	.6142	.23373	.97230	.24039	.1600	.0285	.2785	29
32	.21701	.97617	.22230	.4983	.0244	.6081	.23401	.97223	.24069	.1546	.0285	.2733	28
33	.21729	.97611	.22261	.4921	.0245	.6021	.23429	.97216	.24100	.1493	.0286	.2681	27
34	.21757	.97604	.22291	.4860	.0245	.5961	.23458	.97210	.24131	.1440	.0287	.2630	26
35	0.21786	0.97598	0.22322	4.4799	1.0246	4.5901	0.23486	0.97203	0.24162	4.1388	1.0288	4.2579	25
36	.21814	.97592	.22353	.4737	.0247	.5841	.23514	.97196	.24192	.1335	.0288	.2527	24
37	.21843	.97585	.22383	.4676	.0247	.5782	.23542	.97189	.24223	.1282	.0289	.2476	23
38	.21871	.97579	.22414	.4615	.0248	.5722	.23571	.97182	.24254	.1230	.0290	.2425	22
39	.21899	.97573	.22444	.4555	.0249	.5663	.23599	.97175	.24285	.1178	.0291	.2375	21
40	0.21928	0.97566	0.22475	4.4494	1.0249	4.5604	0.23627	0.97169	0.24316	4.1126	1.0291	4.2324	20
41	.21956	.97560	.22505	.4434	.0250	.5545	.23655	.97162	.24346	.1073	.0292	.2273	19
42	.21985	.97553	.22536	.4373	.0251	.5486	.23684	.97155	.24377	.1022	.0293	.2223	18
43	.22013	.97547	.22566	.4313	.0251	.5428	.23712	.97148	.24408	.0970	.0293	.2173	17
44	.22041	.97541	.22597	.4253	.0252	.5369	.23740	.97141	.24439	.0918	.0294	.2122	16
45	0.22070	0.97534	0.22628	4.4194	1.0253	4.5311	0.23768	0.97134	0.24470	4.0867	1.0295	4.2072	15
46	.22098	.97528	.22658	.4134	.0253	.5253	.23797	.97127	.24501	.0815	.0296	.2022	14
47	.22126	.97521	.22689	.4074	.0254	.5195	.23825	.97120	.24531	.0764	.0296	.1972	13
48	.22155	.97515	.22719	.4015	.0255	.5137	.23853	.97113	.24562	.0713	.0297	.1923	12
49	.22183	.97508	.22750	.3956	.0255	.5079	.23881	.97106	.24593	.0662	.0298	.1873	11
50	0.22211	0.97502	0.22781	4.3897	1.0256	4.5021	0.23910	0.97099	0.24624	4.0611	1.0299	4.1824	10
51	.22240	.97495	.22811	.3838	.0257	.4964	.23938	.97092	.24655	.0560	.0299	.1774	9
52	.22268	.97489	.22842	.3779	.0257	.4907	.23966	.97086	.24686	.0509	.0300	.1725	8
53	.22297	.97483	.22872	.3721	.0258	.4850	.23994	.97079	.24717	.0458	.0301	.1676	7
54	.22325	.97476	.22903	.3662	.0259	.4793	.24023	.97072	.24747	.0408	.0302	.1627	6
55	0.22353	0.97470	0.22934	4.3604	1.0260	4.4736	0.24051	0.97065	0.24778	4.0358	1.0302	4.1578	5
56	.22382	.97463	.22964	.3546	.0260	.4679	.24079	.97058	.24809	.0307	.0303	.1529	4
57	.22410	.97457	.22995	.3488	.0261	.4623	.24107	.97051	.24840	.0257	.0304	.1481	3
58	.22438	.97450	.23025	.3430	.0262	.4566	.24136	.97044	.24871	.0207	.0305	.1432	2
59	.22467	.97443	.23056	.3372	.0262	.4510	.24164	.97037	.24902	.0157	.0305	.1384	1
60	0.22495	0.97437	0.23087	4.3315	1.0263	4.4454	0.24192	0.97029	0.24933	4.0108	1.0306	4.1336	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
	102°					77°	103°					76°	

NATURAL TRIGONOMETRIC FUNCTIONS

14°						165°	15°					164°	
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.24192	0.97029	0.24933	4.0108	1.0306	4.1336	0.25882	0.96592	0.26795	3.7320	1.0353	3.8637	60
1	.24220	.97022	.24964	.0058	.0307	.1287	.25910	.96585	.26826	.7277	.0353	.8595	59
2	.24249	.97015	.24995	.0009	.0308	.1239	.25938	.96577	.26857	.7234	.0354	.8553	58
3	.24277	.97008	.25025	3.9959	.0308	.1191	.25966	.96570	.26888	.7191	.0355	.8512	57
4	.24305	.97001	.25056	.9910	.0309	.1144	.25994	.96562	.26920	.7147	.0356	.8470	56
5	0.24333	0.96994	0.25087	3.9861	1.0310	4.1096	0.26022	0.96555	0.26951	3.7104	1.0357	3.8428	55
6	.24361	.96987	.25118	.9812	.0311	.1048	.26050	.96547	.26982	.7062	.0358	.8387	54
7	.24390	.96980	.25149	.9763	.0311	.1001	.26078	.96540	.27013	.7019	.0358	.8346	53
8	.24418	.96973	.25180	.9714	.0312	.0953	.26107	.96532	.27044	.6976	.0359	.8304	52
9	.24446	.96966	.25211	.9665	.0313	.0906	.26135	.96524	.27076	.6933	.0360	.8263	51
10	0.24474	0.96959	0.25242	3.9616	1.0314	4.0859	0.26163	0.96517	0.27107	3.6891	1.0361	3.8222	50
11	.24502	.96952	.25273	.9568	.0314	.0812	.26191	.96509	.27138	.6848	.0362	.8181	49
12	.24531	.96944	.25304	.9520	.0315	.0765	.26219	.96502	.27169	.6806	.0362	.8140	48
13	.24559	.96937	.25335	.9471	.0316	.0718	.26247	.96494	.27201	.6764	.0363	.8100	47
14	.24587	.96930	.25366	.9423	.0317	.0672	.26275	.96486	.27232	.6722	.0364	.8059	46
15	0.24615	0.96923	0.25397	3.9375	1.0317	4.0625	0.26303	0.96479	0.27263	3.6679	1.0365	3.8018	45
16	.24643	.96916	.25428	.9327	.0318	.0579	.26331	.96471	.27294	.6637	.0366	.7978	44
17	.24672	.96909	.25459	.9279	.0319	.0532	.26359	.96463	.27326	.6596	.0367	.7937	43
18	.24700	.96901	.25490	.9231	.0320	.0486	.26387	.96456	.27357	.6554	.0367	.7897	42
19	.24728	.96894	.25521	.9184	.0320	.0440	.26415	.96448	.27388	.6512	.0368	.7857	41
20	0.24756	0.96887	0.25552	3.9136	1.0321	4.0394	0.26443	0.96440	0.27419	3.6470	1.0369	3.7816	40
21	.24784	.96880	.25583	.9089	.0322	.0348	.26471	.96433	.27451	.6429	.0370	.7776	39
22	.24813	.96873	.25614	.9042	.0323	.0302	.26499	.96425	.27482	.6387	.0371	.7736	38
23	.24841	.96865	.25645	.8994	.0323	.0256	.26527	.96417	.27513	.6346	.0371	.7697	37
24	.24869	.96858	.25676	.8947	.0324	.0211	.26556	.96409	.27544	.6305	.0372	.7657	36
25	0.24897	0.96851	0.25707	3.8900	1.0325	4.0165	0.26584	0.96402	0.27576	3.6263	1.0373	3.7617	35
26	.24925	.96844	.25738	.8853	.0326	.0120	.26612	.96394	.27607	.6222	.0374	.7577	34
27	.24953	.96836	.25769	.8807	.0327	.0074	.26640	.96386	.27638	.6181	.0375	.7538	33
28	.24982	.96829	.25800	.8760	.0327	.0029	.26668	.96378	.27670	.6140	.0376	.7498	32
29	.25010	.96822	.25831	.8713	.0328	3.9984	.26696	.96371	.27701	.6100	.0376	.7459	31
30	0.25038	0.96815	0.25862	3.8667	1.0329	3.9939	0.26724	0.96363	0.27732	3.6059	1.0377	3.7420	30
31	.25066	.96807	.25893	.8621	.0330	.9894	.26752	.96355	.27764	.6018	.0378	.7380	29
32	.25094	.96800	.25924	.8574	.0330	.9850	.26780	.96347	.27795	.5977	.0379	.7341	28
33	.25122	.96793	.25955	.8528	.0331	.9805	.26808	.96340	.27826	.5937	.0380	.7302	27
34	.25151	.96785	.25986	.8482	.0332	.9760	.26836	.96332	.27858	.5896	.0381	.7263	26
35	0.25179	0.96778	0.26017	3.8436	1.0333	3.9716	0.26864	0.96324	0.27889	3.5856	1.0382	3.7224	25
36	.25207	.96771	.26048	.8390	.0334	.9672	.26892	.96316	.27920	.5816	.0382	.7186	24
37	.25235	.96763	.26079	.8345	.0334	.9627	.26920	.96308	.27952	.5776	.0383	.7147	23
38	.25263	.96756	.26110	.8299	.0335	.9583	.26948	.96301	.27983	.5736	.0384	.7108	22
39	.25291	.96749	.26141	.8254	.0336	.9539	.26976	.96293	.28014	.5696	.0385	.7070	21
40	0.25319	0.96741	0.26172	3.8208	1.0337	3.9495	0.27004	0.96285	0.28046	3.5656	1.0386	3.7031	20
41	.25348	.96734	.26203	.8163	.0338	.9451	.27032	.96277	.28077	.5616	.0387	.6993	19
42	.25376	.96727	.26234	.8118	.0338	.9408	.27060	.96269	.28109	.5576	.0387	.6955	18
43	.25404	.96719	.26266	.8073	.0339	.9364	.27088	.96261	.28140	.5536	.0388	.6917	17
44	.25432	.96712	.26297	.8027	.0340	.9320	.27116	.96253	.28171	.5497	.0389	.6878	16
45	0.25460	0.96704	0.26328	3.7983	1.0341	3.9277	0.27144	0.96245	0.28203	3.5457	1.0390	3.6840	15
46	.25488	.96697	.26359	.7938	.0341	.9234	.27172	.96238	.28234	.5418	.0391	.6802	14
47	.25516	.96690	.26390	.7893	.0342	.9190	.27200	.96230	.28266	.5378	.0392	.6765	13
48	.25544	.96682	.26421	.7848	.0343	.9147	.27228	.96222	.28297	.5339	.0393	.6727	12
49	.25573	.96675	.26452	.7804	.0344	.9104	.27256	.96214	.28328	.5300	.0393	.6689	11
50	0.25601	0.96667	0.26483	3.7759	1.0345	3.9061	0.27284	0.96206	0.28360	3.5261	1.0394	3.6651	10
51	.25629	.96660	.26514	.7715	.0345	.9018	.27312	.96198	.28391	.5222	.0395	.6614	9
52	.25657	.96652	.26546	.7671	.0346	.8976	.27340	.96190	.28423	.5183	.0396	.6576	8
53	.25685	.96645	.26577	.7627	.0347	.8933	.27368	.96182	.28454	.5144	.0397	.6539	7
54	.25713	.96638	.26608	.7583	.0348	.8890	.27396	.96174	.28486	.5105	.0398	.6502	6
55	0.25741	0.96630	0.26639	3.7539	1.0349	3.8848	0.27424	0.96166	0.28517	3.5066	1.0399	3.6464	5
56	.25769	.96623	.26670	.7495	.0349	.8805	.27452	.96158	.28549	.5028	.0399	.6427	4
57	.25798	.96615	.26701	.7451	.0350	.8763	.27480	.96150	.28580	.4989	.0400	.6390	3
58	.25826	.96608	.26732	.7407	.0351	.8721	.27508	.96142	.28611	.4951	.0401	.6353	2
59	.25854	.96600	.26764	.7364	.0352	.8679	.27536	.96134	.28643	.4912	.0402	.6316	1
60	0.25882	0.96592	0.26795	3.7320	1.0353	3.8637	0.27564	0.96126	0.28674	3.4874	1.0403	3.6279	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
104°						75°	105°					74°	

NATURAL TRIGONOMETRIC FUNCTIONS

16°						163°	17°					162°	
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.27564	0.96126	0.28674	3.4874	1.0403	3.6279	0.29237	0.95630	0.30573	3.2708	1.0457	3.4203	60
1	.27592	.96118	.28706	.4836	.0404	.6243	.29265	.95622	.30605	.2674	.0458	.4170	59
2	.27620	.96110	.28737	.4798	.0405	.6206	.29293	.95613	.30637	.2640	.0459	.4138	58
3	.27648	.96102	.28769	.4760	.0406	.6169	.29321	.95605	.30668	.2607	.0460	.4106	57
4	.27675	.96094	.28800	.4722	.0406	.6133	.29348	.95596	.30700	.2573	.0461	.4073	56
5	0.27703	0.96086	0.28832	3.4684	1.0407	3.6096	0.29376	0.95588	0.30732	3.2539	1.0461	3.4041	55
6	.27731	.96078	.28863	.4646	.0408	.6060	.29404	.95579	.30764	.2505	.0462	.4009	54
7	.27759	.96070	.28895	.4608	.0409	.6024	.29432	.95571	.30796	.2472	.0463	.3977	53
8	.27787	.96062	.28926	.4570	.0410	.5987	.29460	.95562	.30828	.2438	.0464	.3945	52
9	.27815	.96054	.28958	.4533	.0411	.5951	.29487	.95554	.30859	.2405	.0465	.3913	51
10	0.27843	0.96045	0.28990	3.4495	1.0412	3.5915	0.29515	0.95545	0.30891	3.2371	1.0466	3.3881	50
11	.27871	.96037	.29021	.4458	.0413	.5879	.29543	.95536	.30923	.2338	.0467	.3849	49
12	.27899	.96029	.29053	.4420	.0413	.5843	.29571	.95528	.30955	.2305	.0468	.3817	48
13	.27927	.96021	.29084	.4383	.0414	.5807	.29598	.95519	.30987	.2271	.0469	.3785	47
14	.27955	.96013	.29116	.4346	.0415	.5772	.29626	.95511	.31019	.2238	.0470	.3754	46
15	0.27983	0.96005	0.29147	3.4308	1.0416	3.5736	0.29654	0.95502	0.31051	3.2205	1.0471	3.3722	45
16	.28011	.95997	.29179	.4271	.0417	.5700	.29682	.95493	.31083	.2172	.0472	.3690	44
17	.28039	.95989	.29210	.4234	.0418	.5665	.29710	.95485	.31115	.2139	.0473	.3659	43
18	.28067	.95980	.29242	.4197	.0419	.5629	.29737	.95476	.31146	.2106	.0474	.3627	42
19	.28094	.95972	.29274	.4160	.0420	.5594	.29765	.95467	.31178	.2073	.0475	.3596	41
20	0.28122	0.95964	0.29305	3.4124	1.0420	3.5559	0.29793	0.95459	0.31210	3.2041	1.0476	3.3565	40
21	.28150	.95956	.29337	.4087	.0421	.5523	.29821	.95450	.31242	.2008	.0477	.3534	39
22	.28178	.95948	.29368	.4050	.0422	.5488	.29848	.95441	.31274	.1975	.0478	.3502	38
23	.28206	.95940	.29400	.4014	.0423	.5453	.29876	.95433	.31306	.1942	.0478	.3471	37
24	.28234	.95931	.29432	.3977	.0424	.5418	.29904	.95424	.31338	.1910	.0479	.3440	36
25	0.28262	0.95923	0.29463	3.3941	1.0425	3.5383	0.29932	0.95415	0.31370	3.1877	1.0480	3.3409	35
26	.28290	.95915	.29495	.3904	.0426	.5348	.29959	.95407	.31402	.1845	.0481	.3378	34
27	.28318	.95907	.29526	.3868	.0427	.5313	.29987	.95398	.31434	.1813	.0482	.3347	33
28	.28346	.95898	.29558	.3832	.0428	.5279	.30015	.95389	.31466	.1780	.0483	.3316	32
29	.28374	.95890	.29590	.3795	.0428	.5244	.30043	.95380	.31498	.1748	.0484	.3286	31
30	0.28401	0.95882	0.29621	3.3759	1.0429	3.5209	0.30070	0.95372	0.31530	3.1716	1.0485	3.3255	30
31	.28429	.95874	.29653	.3723	.0430	.5175	.30098	.95363	.31562	.1684	.0486	.3224	29
32	.28457	.95865	.29685	.3687	.0431	.5140	.30126	.95354	.31594	.1652	.0487	.3194	28
33	.28485	.95857	.29716	.3651	.0432	.5106	.30154	.95345	.31626	.1620	.0488	.3163	27
34	.28513	.95849	.29748	.3616	.0433	.5072	.30181	.95337	.31658	.1588	.0489	.3133	26
35	0.28541	0.95840	0.29780	3.3580	1.0434	3.5037	0.30209	0.95328	0.31690	3.1556	1.0490	3.3102	25
36	.28569	.95832	.29811	.3544	.0435	.5003	.30237	.95319	.31722	.1524	.0491	.3072	24
37	.28597	.95824	.29843	.3509	.0436	.4969	.30265	.95310	.31754	.1492	.0492	.3042	23
38	.28624	.95816	.29875	.3473	.0437	.4935	.30292	.95301	.31786	.1460	.0493	.3011	22
39	.28652	.95807	.29906	.3438	.0438	.4901	.30320	.95293	.31818	.1429	.0494	.2981	21
40	0.28680	0.95799	0.29938	3.3402	1.0438	3.4867	0.30348	0.95284	0.31850	3.1397	1.0495	3.2951	20
41	.28708	.95791	.29970	.3367	.0439	.4833	.30375	.95275	.31882	.1366	.0496	.2921	19
42	.28736	.95782	.30001	.3332	.0440	.4799	.30403	.95266	.31914	.1334	.0497	.2891	18
43	.28764	.95774	.30033	.3296	.0441	.4766	.30431	.95257	.31946	.1303	.0498	.2861	17
44	.28792	.95765	.30065	.3261	.0442	.4732	.30459	.95248	.31978	.1271	.0499	.2831	16
45	0.28820	0.95757	0.30096	3.3226	1.0443	3.4698	0.30486	0.95239	0.32010	3.1240	1.0500	3.2801	15
46	.28847	.95749	.30128	.3191	.0444	.4665	.30514	.95231	.32042	.1209	.0501	.2772	14
47	.28875	.95740	.30160	.3156	.0445	.4632	.30542	.95222	.32074	.1177	.0502	.2742	13
48	.28903	.95732	.30192	.3121	.0446	.4598	.30569	.95213	.32106	.1146	.0503	.2712	12
49	.28931	.95723	.30223	.3087	.0447	.4565	.30597	.95204	.32138	.1115	.0504	.2683	11
50	0.28959	0.95715	0.30255	3.3052	1.0448	3.4532	0.30625	0.95195	0.32171	3.1084	1.0505	3.2653	10
51	.28987	.95707	.30287	.3017	.0448	.4498	.30653	.95186	.32203	.1053	.0506	.2624	9
52	.29014	.95698	.30319	.2983	.0449	.4465	.30680	.95177	.32235	.1022	.0507	.2594	8
53	.29042	.95690	.30350	.2948	.0450	.4432	.30708	.95168	.32267	.0991	.0508	.2565	7
54	.29070	.95681	.30382	.2914	.0451	.4399	.30736	.95159	.32299	.0960	.0509	.2535	6
55	0.29098	0.95673	0.30414	3.2879	1.0452	3.4366	0.30763	0.95150	0.32331	3.0930	1.0510	3.2506	5
56	.29126	.95664	.30446	.2845	.0453	.4334	.30791	.95141	.32363	.0899	.0511	.2477	4
57	.29154	.95656	.30478	.2811	.0454	.4301	.30819	.95132	.32395	.0868	.0512	.2448	3
58	.29181	.95647	.30509	.2777	.0455	.4268	.30846	.95124	.32428	.0838	.0513	.2419	2
59	.29209	.95639	.30541	.2742	.0456	.4236	.30874	.95115	.32460	.0807	.0514	.2390	1
60	0.29237	0.95630	0.30573	3.2708	1.0457	3.4203	0.30902	0.95106	0.32492	3.0777	1.0515	3.2361	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
106°						73°	107°					72°	

NATURAL TRIGONOMETRIC FUNCTIONS

18°						161°	19°						160°
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.30902	0.95106	0.32492	3.0777	1.0515	3.2361	0.32557	0.94552	0.34433	2.9042	1.0576	3.0715	60
1	.30929	.95097	.32524	.0746	.0516	.2332	.32584	.94542	.34465	.9015	.0577	.0690	59
2	.30957	.95088	.32556	.0716	.0517	.2303	.32612	.94533	.34498	.8987	.0578	.0664	58
3	.30985	.95079	.32588	.0686	.0518	.2274	.32639	.94523	.34530	.8960	.0579	.0638	57
4	.31012	.95070	.32621	.0655	.0519	.2245	.32667	.94514	.34563	.8933	.0580	.0612	56
5	0.31040	0.95061	0.32653	3.0625	1.0520	3.2216	0.32694	0.94504	0.34595	2.8905	1.0581	3.0586	55
6	.31068	.95051	.32685	.0595	.0521	.2188	.32722	.94495	.34628	.8878	.0582	.0561	54
7	.31095	.95042	.32717	.0565	.0522	.2159	.32749	.94485	.34661	.8851	.0584	.0535	53
8	.31123	.95033	.32749	.0535	.0523	.2131	.32777	.94476	.34693	.8824	.0585	.0509	52
9	.31150	.95024	.32782	.0505	.0524	.2102	.32804	.94466	.34726	.8797	.0586	.0484	51
10	0.31178	0.95015	0.32814	3.0475	1.0525	3.2074	0.32832	0.94457	0.34758	2.8770	1.0587	3.0458	50
11	.31206	.95006	.32846	.0445	.0526	.2045	.32859	.94447	.34791	.8743	.0588	.0433	49
12	.31233	.94997	.32878	.0415	.0527	.2017	.32887	.94438	.34824	.8716	.0589	.0407	48
13	.31261	.94988	.32910	.0385	.0528	.1989	.32914	.94428	.34856	.8689	.0590	.0382	47
14	.31289	.94979	.32943	.0356	.0529	.1960	.32942	.94418	.34889	.8662	.0591	.0357	46
15	0.31316	0.94970	0.32975	3.0326	1.0530	3.1932	0.32969	0.94409	0.34921	2.8636	1.0592	3.0331	45
16	.31344	.94961	.33007	.0296	.0531	.1904	.32996	.94399	.34954	.8609	.0593	.0306	44
17	.31372	.94952	.33039	.0267	.0532	.1876	.33024	.94390	.34987	.8582	.0594	.0281	43
18	.31399	.94942	.33072	.0237	.0533	.1848	.33051	.94380	.35019	.8555	.0595	.0256	42
19	.31427	.94933	.33104	.0208	.0534	.1820	.33079	.94370	.35052	.8529	.0596	.0231	41
20	0.31454	0.94924	0.33136	3.0178	1.0535	3.1792	0.33106	0.94361	0.35085	2.8502	1.0598	3.0206	40
21	.31482	.94915	.33169	.0149	.0536	.1764	.33134	.94351	.35117	.8476	.0599	.0181	39
22	.31510	.94906	.33201	.0120	.0537	.1736	.33161	.94341	.35150	.8449	.0600	.0156	38
23	.31537	.94897	.33233	.0090	.0538	.1708	.33189	.94332	.35183	.8423	.0601	.0131	37
24	.31565	.94888	.33265	.0061	.0539	.1681	.33216	.94322	.35215	.8396	.0602	.0106	36
25	0.31592	0.94878	0.33298	3.0032	1.0540	3.1653	0.33243	0.94313	0.35248	2.8370	1.0603	3.0081	35
26	.31620	.94869	.33330	.0003	.0541	.1625	.33271	.94303	.35281	.8344	.0604	.0056	34
27	.31648	.94860	.33362	2.9974	.0542	.1598	.33298	.94293	.35314	.8318	.0605	.0031	33
28	.31675	.94851	.33395	.9945	.0543	.1570	.33326	.94283	.35346	.8291	.0606	.0007	32
29	.31703	.94841	.33427	.9916	.0544	.1543	.33353	.94274	.35379	.8265	.0607	2.9982	31
30	0.31730	0.94832	0.33459	2.9887	1.0545	3.1515	0.33381	0.94264	0.35412	2.8239	1.0608	2.9957	30
31	.31758	.94823	.33492	.9858	.0546	.1488	.33408	.94254	.35445	.8213	.0609	.9933	29
32	.31786	.94814	.33524	.9829	.0547	.1461	.33435	.94245	.35477	.8187	.0611	.9908	28
33	.31813	.94805	.33557	.9800	.0548	.1433	.33463	.94235	.35510	.8161	.0612	.9884	27
34	.31841	.94795	.33589	.9772	.0549	.1406	.33490	.94225	.35543	.8135	.0613	.9859	26
35	0.31868	0.94786	0.33621	2.9743	1.0550	3.1379	0.33518	0.94215	0.35576	2.8109	1.0614	2.9835	25
36	.31896	.94777	.33654	.9714	.0551	.1352	.33545	.94206	.35608	.8083	.0615	.9810	24
37	.31923	.94767	.33686	.9686	.0552	.1325	.33572	.94196	.35641	.8057	.0616	.9786	23
38	.31951	.94758	.33718	.9657	.0553	.1298	.33600	.94186	.35674	.8032	.0617	.9762	22
39	.31978	.94749	.33751	.9629	.0554	.1271	.33627	.94176	.35707	.8006	.0618	.9738	21
40	0.32006	0.94740	0.33783	2.9600	1.0555	3.1244	0.33655	0.94167	0.35739	2.7980	1.0619	2.9713	20
41	.32034	.94730	.33816	.9572	.0556	.1217	.33682	.94157	.35772	.7954	.0620	.9689	19
42	.32061	.94721	.33848	.9544	.0557	.1190	.33709	.94147	.35805	.7929	.0622	.9665	18
43	.32089	.94712	.33880	.9515	.0558	.1163	.33737	.94137	.35838	.7903	.0623	.9641	17
44	.32116	.94702	.33913	.9487	.0559	.1137	.33764	.94127	.35871	.7878	.0624	.9617	16
45	0.32144	0.94693	0.33945	2.9459	1.0560	3.1110	0.33792	0.94118	0.35904	2.7852	1.0625	2.9593	15
46	.32171	.94684	.33978	.9431	.0561	.1083	.33819	.94108	.35936	.7827	.0626	.9569	14
47	.32199	.94674	.34010	.9403	.0562	.1057	.33846	.94098	.35969	.7801	.0627	.9545	13
48	.32226	.94665	.34043	.9375	.0563	.1030	.33874	.94088	.36002	.7776	.0628	.9521	12
49	.32254	.94655	.34075	.9347	.0565	.1004	.33901	.94078	.36035	.7751	.0629	.9497	11
50	0.32282	0.94646	0.34108	2.9319	1.0566	3.0977	0.33928	0.94068	0.36068	2.7725	1.0630	2.9474	10
51	.32309	.94637	.34140	.9291	.0567	.0951	.33956	.94058	.36101	.7700	.0632	.9450	9
52	.32337	.94627	.34173	.9263	.0568	.0925	.33983	.94049	.36134	.7675	.0633	.9426	8
53	.32364	.94618	.34205	.9235	.0569	.0898	.34011	.94039	.36167	.7650	.0634	.9402	7
54	.32392	.94608	.34238	.9208	.0570	.0872	.34038	.94029	.36199	.7625	.0635	.9379	6
55	0.32419	0.94599	0.34270	2.9180	1.0571	3.0846	0.34065	0.94019	0.36232	2.7600	1.0636	2.9355	5
56	.32447	.94590	.34303	.9152	.0572	.0820	.34093	.94009	.36265	.7575	.0637	.9332	4
57	.32474	.94580	.34335	.9125	.0573	.0793	.34120	.93999	.36298	.7550	.0638	.9308	3
58	.32502	.94571	.34368	.9097	.0574	.0767	.34147	.93989	.36331	.7525	.0639	.9285	2
59	.32529	.94561	.34400	.9069	.0575	.0741	.34175	.93979	.36364	.7500	.0641	.9261	1
60	0.32557	0.94552	0.34433	2.9042	1.0576	3.0715	0.34202	0.93969	0.36397	2.7475	1.0642	2.9238	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
108°						71°	109°						70°

NATURAL TRIGONOMETRIC FUNCTIONS

20°						159°	21°					158°	
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.34202	0.93969	0.36397	2.7475	1.0642	2.9238	0.35837	0.93358	0.38386	2.6051	1.0711	2.7904	60
1	.34229	.93959	.36430	.7450	.0643	.9215	.35864	.93348	.38420	.6028	.0713	.7883	59
2	.34257	.93949	.36463	.7425	.0644	.9191	.35891	.93337	.38453	.6006	.0714	.7862	58
3	.34284	.93939	.36496	.7400	.0645	.9168	.35918	.93327	.38486	.5983	.0715	.7841	57
4	.34311	.93929	.36529	.7376	.0646	.9145	.35945	.93316	.38520	.5960	.0716	.7820	56
5	0.34339	0.93919	0.36562	2.7351	1.0647	2.9122	0.35972	0.93306	0.38553	2.5938	1.0717	2.7799	55
6	.34366	.93909	.36595	.7326	.0648	.9098	.36000	.93295	.38587	.5916	.0719	.7778	54
7	.34393	.93899	.36628	.7302	.0650	.9075	.36027	.93285	.38620	.5893	.0720	.7757	53
8	.34421	.93889	.36661	.7277	.0651	.9052	.36054	.93274	.38654	.5871	.0721	.7736	52
9	.34448	.93879	.36694	.7252	.0652	.9029	.36081	.93264	.38687	.5848	.0722	.7715	51
10	0.34475	0.93869	0.36727	2.7228	1.0653	2.9006	0.36108	0.93253	0.38720	2.5826	1.0723	2.7694	50
11	.34502	.93859	.36760	.7204	.0654	.8983	.36135	.93243	.38754	.5804	.0725	.7674	49
12	.34530	.93849	.36793	.7179	.0655	.8960	.36162	.93232	.38787	.5781	.0726	.7653	48
13	.34557	.93839	.36826	.7155	.0656	.8937	.36189	.93222	.38821	.5759	.0727	.7632	47
14	.34584	.93829	.36859	.7130	.0658	.8915	.36217	.93211	.38854	.5737	.0728	.7611	46
15	0.34612	0.93819	0.36892	2.7106	1.0659	2.8892	0.36244	0.93201	0.38888	2.5715	1.0729	2.7591	45
16	.34639	.93809	.36925	.7082	.0660	.8869	.36271	.93190	.38921	.5693	.0731	.7570	44
17	.34666	.93799	.36958	.7058	.0661	.8846	.36298	.93180	.38955	.5671	.0732	.7550	43
18	.34693	.93789	.36991	.7033	.0662	.8824	.36325	.93169	.38988	.5649	.0733	.7529	42
19	.34721	.93779	.37024	.7009	.0663	.8801	.36352	.93158	.39022	.5627	.0734	.7509	41
20	0.34748	0.93769	0.37057	2.6985	1.0664	2.8778	0.36379	0.93148	0.39055	2.5605	1.0736	2.7488	40
21	.34775	.93758	.37090	.6961	.0666	.8756	.36406	.93137	.39089	.5583	.0737	.7468	39
22	.34803	.93748	.37123	.6937	.0667	.8733	.36433	.93127	.39122	.5561	.0738	.7447	38
23	.34830	.93738	.37156	.6913	.0668	.8711	.36460	.93116	.39156	.5539	.0739	.7427	37
24	.34857	.93728	.37190	.6889	.0669	.8688	.36488	.93105	.39189	.5517	.0740	.7406	36
25	0.34884	0.93718	0.37223	2.6865	1.0670	2.8666	0.36515	0.93095	0.39223	2.5495	1.0742	2.7386	35
26	.34912	.93708	.37256	.6841	.0671	.8644	.36542	.93084	.39257	.5473	.0743	.7366	34
27	.34939	.93698	.37289	.6817	.0673	.8621	.36569	.93074	.39290	.5451	.0744	.7346	33
28	.34966	.93687	.37322	.6794	.0674	.8599	.36596	.93063	.39324	.5430	.0745	.7325	32
29	.34993	.93677	.37355	.6770	.0675	.8577	.36623	.93052	.39357	.5408	.0747	.7305	31
30	0.35021	0.93667	0.37388	2.6746	1.0676	2.8554	0.36650	0.93042	0.39391	2.5386	1.0748	2.7285	30
31	.35048	.93657	.37422	.6722	.0677	.8532	.36677	.93031	.39425	.5365	.0749	.7265	29
32	.35075	.93647	.37455	.6699	.0678	.8510	.36704	.93020	.39458	.5343	.0750	.7245	28
33	.35102	.93637	.37488	.6675	.0679	.8488	.36731	.93010	.39492	.5322	.0751	.7225	27
34	.35130	.93626	.37521	.6652	.0681	.8466	.36758	.92999	.39525	.5300	.0753	.7205	26
35	0.35157	0.93616	0.37554	2.6628	1.0682	2.8444	0.36785	0.92988	0.39559	2.5278	1.0754	2.7185	25
36	.35184	.93606	.37587	.6604	.0683	.8422	.36812	.92978	.39593	.5257	.0755	.7165	24
37	.35211	.93596	.37621	.6581	.0684	.8400	.36839	.92967	.39626	.5236	.0756	.7145	23
38	.35239	.93585	.37654	.6558	.0685	.8378	.36866	.92956	.39660	.5214	.0758	.7125	22
39	.35266	.93575	.37687	.6534	.0686	.8356	.36893	.92945	.39694	.5193	.0759	.7105	21
40	0.35293	0.93565	0.37720	2.6511	1.0688	2.8334	0.36921	0.92935	0.39727	2.5171	1.0760	2.7085	20
41	.35320	.93555	.37754	.6487	.0689	.8312	.36948	.92924	.39761	.5150	.0761	.7065	19
42	.35347	.93544	.37787	.6464	.0690	.8290	.36975	.92913	.39795	.5129	.0763	.7045	18
43	.35375	.93534	.37820	.6441	.0691	.8269	.37002	.92902	.39828	.5108	.0764	.7026	17
44	.35402	.93524	.37853	.6418	.0692	.8247	.37029	.92892	.39862	.5086	.0765	.7006	16
45	0.35429	0.93513	0.37887	2.6394	1.0694	2.8225	0.37056	0.92881	0.39896	2.5065	1.0766	2.6986	15
46	.35456	.93503	.37920	.6371	.0695	.8204	.37083	.92870	.39930	.5044	.0768	.6967	14
47	.35483	.93493	.37953	.6348	.0696	.8182	.37110	.92859	.39963	.5023	.0769	.6947	13
48	.35511	.93482	.37986	.6325	.0697	.8160	.37137	.92848	.39997	.5002	.0770	.6927	12
49	.35538	.93472	.38020	.6302	.0698	.8139	.37164	.92838	.40031	.4981	.0771	.6908	11
50	0.35565	0.93462	0.38053	2.6279	1.0699	2.8117	0.37191	0.92827	0.40065	2.4960	1.0773	2.6888	10
51	.35592	.93451	.38086	.6256	.0701	.8096	.37218	.92816	.40098	.4939	.0774	.6869	9
52	.35619	.93441	.38120	.6233	.0702	.8074	.37245	.92805	.40132	.4918	.0775	.6849	8
53	.35647	.93431	.38153	.6210	.0703	.8053	.37272	.92794	.40166	.4897	.0776	.6830	7
54	.35674	.93420	.38186	.6187	.0704	.8032	.37299	.92784	.40200	.4876	.0778	.6810	6
55	0.35701	0.93410	0.38220	2.6164	1.0705	2.8010	0.37326	0.92773	0.40233	2.4855	1.0779	2.6791	5
56	.35728	.93400	.38253	.6142	.0707	.7989	.37353	.92762	.40267	.4834	.0780	.6772	4
57	.35755	.93389	.38286	.6119	.0708	.7968	.37380	.92751	.40301	.4813	.0781	.6752	3
58	.35782	.93379	.38320	.6096	.0709	.7947	.37407	.92740	.40335	.4792	.0783	.6733	2
59	.35810	.93368	.38353	.6073	.0710	.7925	.37434	.92729	.40369	.4772	.0784	.6714	1
60	0.35837	0.93358	0.38386	2.6051	1.0711	2.7904	0.37461	0.92718	0.40403	2.4751	1.0785	2.6695	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
110°						69°	111°					68°	

NATURAL TRIGONOMETRIC FUNCTIONS

22°						157°	23°					156°	
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.37461	0.92718	0.40403	2.4751	1.0785	2.6695	0.39073	0.92050	0.42447	2.3558	1.0864	2.5593	60
1	.37488	.92707	.40436	.4730	.0787	.6675	.39100	.92039	.42482	.3539	.0865	.5575	59
2	.37514	.92696	.40470	.4709	.0788	.6656	.39126	.92028	.42516	.3520	.0866	.5558	58
3	.37541	.92686	.40504	.4689	.0789	.6637	.39153	.92016	.42550	.3501	.0868	.5540	57
4	.37568	.92675	.40538	.4668	.0790	.6618	.39180	.92005	.42585	.3482	.0869	.5523	56
5	0.37595	0.92664	0.40572	2.4647	1.0792	2.6599	0.39207	0.91993	0.42619	2.3463	1.0870	2.5506	55
6	.37622	.92653	.40606	.4627	.0793	.6580	.39234	.91982	.42654	.3445	.0872	.5488	54
7	.37649	.92642	.40640	.4606	.0794	.6561	.39260	.91971	.42688	.3426	.0873	.5471	53
8	.37676	.92631	.40673	.4586	.0795	.6542	.39287	.91959	.42722	.3407	.0874	.5453	52
9	.37703	.92620	.40707	.4565	.0797	.6523	.39314	.91948	.42757	.3388	.0876	.5436	51
10	0.37730	0.92609	0.40741	2.4545	1.0798	2.6504	0.39341	0.91936	0.42791	2.3369	1.0877	2.5419	50
11	.37757	.92598	.40775	.4525	.0799	.6485	.39367	.91925	.42826	.3350	.0878	.5402	49
12	.37784	.92587	.40809	.4504	.0801	.6466	.39394	.91913	.42860	.3332	.0880	.5384	48
13	.37811	.92576	.40843	.4484	.0802	.6447	.39421	.91902	.42894	.3313	.0881	.5367	47
14	.37838	.92565	.40877	.4463	.0803	.6428	.39448	.91891	.42929	.3294	.0882	.5350	46
15	0.37865	0.92554	0.40911	2.4443	1.0804	2.6410	0.39474	0.91879	0.42963	2.3276	1.0884	2.5333	45
16	.37892	.92543	.40945	.4423	.0806	.6391	.39501	.91868	.42998	.3257	.0885	.5316	44
17	.37919	.92532	.40979	.4403	.0807	.6372	.39528	.91856	.43032	.3238	.0886	.5299	43
18	.37946	.92521	.41013	.4382	.0808	.6353	.39554	.91845	.43067	.3220	.0888	.5281	42
19	.37972	.92510	.41047	.4362	.0810	.6335	.39581	.91833	.43101	.3201	.0889	.5264	41
20	0.37999	0.92499	0.41081	2.4342	1.0811	2.6316	0.39608	0.91822	0.43136	2.3183	1.0891	2.5247	40
21	.38026	.92488	.41115	.4322	.0812	.6297	.39635	.91810	.43170	.3164	.0892	.5230	39
22	.38053	.92477	.41149	.4302	.0813	.6279	.39661	.91798	.43205	.3145	.0893	.5213	38
23	.38080	.92466	.41183	.4282	.0815	.6260	.39688	.91787	.43239	.3127	.0895	.5196	37
24	.38107	.92455	.41217	.4262	.0816	.6242	.39715	.91775	.43274	.3109	.0896	.5179	36
25	0.38134	0.92443	0.41251	2.4242	1.0817	2.6223	0.39741	0.91764	0.43308	2.3090	1.0897	2.5163	35
26	.38161	.92432	.41285	.4222	.0819	.6205	.39768	.91752	.43343	.3072	.0899	.5146	34
27	.38188	.92421	.41319	.4202	.0820	.6186	.39795	.91741	.43377	.3053	.0900	.5129	33
28	.38214	.92410	.41353	.4182	.0821	.6168	.39821	.91729	.43412	.3035	.0902	.5112	32
29	.38241	.92399	.41387	.4162	.0823	.6150	.39848	.91718	.43447	.3017	.0903	.5095	31
30	0.38268	0.92388	0.41421	2.4142	1.0824	2.6131	0.39875	0.91706	0.43481	2.2998	1.0904	2.5078	30
31	.38295	.92377	.41455	.4122	.0825	.6113	.39901	.91694	.43516	.2980	.0906	.5062	29
32	.38322	.92366	.41489	.4102	.0826	.6095	.39928	.91683	.43550	.2962	.0907	.5045	28
33	.38349	.92354	.41524	.4083	.0828	.6076	.39955	.91671	.43585	.2944	.0908	.5028	27
34	.38376	.92343	.41558	.4063	.0829	.6058	.39981	.91659	.43620	.2925	.0910	.5011	26
35	0.38403	0.92332	0.41592	2.4043	1.0830	2.6040	0.40008	0.91648	0.43654	2.2907	1.0911	2.4995	25
36	.38429	.92321	.41626	.4023	.0832	.6022	.40035	.91636	.43689	.2889	.0913	.4978	24
37	.38456	.92310	.41660	.4004	.0833	.6003	.40061	.91625	.43723	.2871	.0914	.4961	23
38	.38483	.92299	.41694	.3984	.0834	.5985	.40088	.91613	.43758	.2853	.0915	.4945	22
39	.38510	.92287	.41728	.3964	.0836	.5967	.40115	.91601	.43793	.2835	.0917	.4928	21
40	0.38537	0.92276	0.41762	2.3945	1.0837	2.5949	0.40141	0.91590	0.43827	2.2817	1.0918	2.4912	20
41	.38564	.92265	.41797	.3925	.0838	.5931	.40168	.91578	.43862	.2799	.0920	.4895	19
42	.38591	.92254	.41831	.3906	.0840	.5913	.40195	.91566	.43897	.2781	.0921	.4879	18
43	.38617	.92242	.41865	.3886	.0841	.5895	.40221	.91554	.43932	.2763	.0922	.4862	17
44	.38644	.92231	.41899	.3867	.0842	.5877	.40248	.91543	.43966	.2745	.0924	.4846	16
45	0.38671	0.92220	0.41933	2.3847	1.0844	2.5859	0.40275	0.91531	0.44001	2.2727	1.0925	2.4829	15
46	.38698	.92209	.41968	.3828	.0845	.5841	.40301	.91519	.44036	.2709	.0927	.4813	14
47	.38725	.92197	.42002	.3808	.0846	.5823	.40328	.91508	.44070	.2691	.0928	.4797	13
48	.38751	.92186	.42036	.3789	.0847	.5805	.40354	.91496	.44105	.2673	.0929	.4780	12
49	.38778	.92175	.42070	.3770	.0849	.5787	.40381	.91484	.44140	.2655	.0931	.4764	11
50	0.38805	0.92164	0.42105	2.3750	1.0850	2.5770	0.40408	0.91472	0.44175	2.2637	1.0932	2.4748	10
51	.38832	.92152	.42139	.3731	.0851	.5752	.40434	.91461	.44209	.2619	.0934	.4731	9
52	.38859	.92141	.42173	.3712	.0853	.5734	.40461	.91449	.44244	.2602	.0935	.4715	8
53	.38886	.92130	.42207	.3692	.0854	.5716	.40487	.91437	.44279	.2584	.0936	.4699	7
54	.38912	.92118	.42242	.3673	.0855	.5699	.40514	.91425	.44314	.2566	.0938	.4683	6
55	0.38939	0.92107	0.42276	2.3654	1.0857	2.5681	0.40541	0.91414	0.44349	2.2548	1.0939	2.4666	5
56	.38966	.92096	.42310	.3635	.0858	.5663	.40567	.91402	.44383	.2531	.0941	.4650	4
57	.38993	.92084	.42344	.3616	.0859	.5646	.40594	.91390	.44418	.2513	.0942	.4634	3
58	.39019	.92073	.42379	.3597	.0861	.5628	.40620	.91378	.44453	.2495	.0943	.4618	2
59	.39046	.92062	.42413	.3577	.0862	.5610	.40647	.91366	.44488	.2478	.0945	.4602	1
60	0.39073	0.92050	0.42447	2.3558	1.0864	2.5593	0.40674	0.91354	0.44523	2.2460	1.0946	2.4586	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
112°						67°	113°					66°	

NATURAL TRIGONOMETRIC FUNCTIONS

24°						155°	25°					154°	
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.40674	0.91354	0.44523	2.2460	1.0946	2.4586	0.42262	0.90631	0.46631	2.1445	1.1034	2.3662	60
1	.40700	.91343	.44558	.2443	.0948	.4570	.42288	.90618	.46666	.1429	.1035	.3647	59
2	.40727	.91331	.44593	.2425	.0949	.4554	.42314	.90606	.46702	.1412	.1037	.3632	58
3	.40753	.91319	.44627	.2408	.0951	.4538	.42341	.90594	.46737	.1396	.1038	.3618	57
4	.40780	.91307	.44662	.2390	.0952	.4522	.42367	.90581	.46772	.1380	.1040	.3603	56
5	0.40806	0.91295	0.44697	2.2373	1.0953	2.4506	0.42394	0.90569	0.46808	2.1364	1.1041	2.3588	55
6	.40833	.91283	.44732	.2355	.0955	.4490	.42420	.90557	.46843	.1348	.1043	.3574	54
7	.40860	.91271	.44767	.2338	.0956	.4474	.42446	.90544	.46879	.1331	.1044	.3559	53
8	.40886	.91260	.44802	.2320	.0958	.4458	.42473	.90532	.46914	.1315	.1046	.3544	52
9	.40913	.91248	.44837	.2303	.0959	.4442	.42499	.90520	.46950	.1299	.1047	.3530	51
10	0.40939	0.91236	0.44872	2.2286	1.0961	2.4426	0.42525	0.90507	0.46985	2.1283	1.1049	2.3515	50
11	.40966	.91224	.44907	.2268	.0962	.4411	.42552	.90495	.47021	.1267	.1050	.3501	49
12	.40992	.91212	.44942	.2251	.0963	.4395	.42578	.90483	.47056	.1251	.1052	.3486	48
13	.41019	.91200	.44977	.2234	.0965	.4379	.42604	.90470	.47092	.1235	.1053	.3472	47
14	.41045	.91188	.45012	.2216	.0966	.4363	.42630	.90458	.47127	.1219	.1055	.3457	46
15	0.41072	0.91176	0.45047	2.2199	1.0968	2.4347	0.42657	0.90445	0.47163	2.1203	1.1056	2.3443	45
16	.41098	.91164	.45082	.2182	.0969	.4332	.42683	.90433	.47199	.1187	.1058	.3428	44
17	.41125	.91152	.45117	.2165	.0971	.4316	.42709	.90421	.47234	.1171	.1059	.3414	43
18	.41151	.91140	.45152	.2147	.0972	.4300	.42736	.90408	.47270	.1155	.1061	.3399	42
19	.41178	.91128	.45187	.2130	.0973	.4285	.42762	.90396	.47305	.1139	.1062	.3385	41
20	0.41204	0.91116	0.45222	2.2113	1.0975	2.4269	0.42788	0.90383	0.47341	2.1123	1.1064	2.3371	40
21	.41231	.91104	.45257	.2096	.0976	.4254	.42815	.90371	.47376	.1107	.1065	.3356	39
22	.41257	.91092	.45292	.2079	.0978	.4238	.42841	.90358	.47412	.1092	.1067	.3342	38
23	.41284	.91080	.45327	.2062	.0979	.4222	.42867	.90346	.47448	.1076	.1068	.3328	37
24	.41310	.91068	.45362	.2045	.0981	.4207	.42893	.90333	.47483	.1060	.1070	.3313	36
25	0.41337	0.91056	0.45397	2.2028	1.0982	2.4191	0.42920	0.90321	0.47519	2.1044	1.1072	2.3299	35
26	.41363	.91044	.45432	.2011	.0984	.4176	.42946	.90308	.47555	.1028	.1073	.3285	34
27	.41390	.91032	.45467	.1994	.0985	.4160	.42972	.90296	.47590	.1013	.1075	.3271	33
28	.41416	.91020	.45502	.1977	.0986	.4145	.42998	.90283	.47626	.0997	.1076	.3256	32
29	.41443	.91008	.45537	.1960	.0988	.4130	.43025	.90271	.47662	.0981	.1078	.3242	31
30	0.41469	0.90996	0.45573	2.1943	1.0989	2.4114	0.43051	0.90258	0.47697	2.0965	1.1079	2.3228	30
31	.41496	.90984	.45608	.1926	.0991	.4099	.43077	.90246	.47733	.0950	.1081	.3214	29
32	.41522	.90972	.45643	.1909	.0992	.4083	.43104	.90233	.47769	.0934	.1082	.3200	28
33	.41549	.90960	.45678	.1892	.0994	.4068	.43130	.90221	.47805	.0918	.1084	.3186	27
34	.41575	.90948	.45713	.1875	.0995	.4053	.43156	.90208	.47840	.0903	.1085	.3172	26
35	0.41602	0.90936	0.45748	2.1859	1.0997	2.4037	0.43182	0.90196	0.47876	2.0887	1.1087	2.3158	25
36	.41628	.90924	.45783	.1842	.0998	.4022	.43208	.90183	.47912	.0872	.1088	.3143	24
37	.41654	.90911	.45819	.1825	.1000	.4007	.43235	.90171	.47948	.0856	.1090	.3129	23
38	.41681	.90899	.45854	.1808	.1001	.3992	.43261	.90158	.47983	.0840	.1092	.3115	22
39	.41707	.90887	.45889	.1792	.1003	.3976	.43287	.90145	.48019	.0825	.1093	.3101	21
40	0.41734	0.90875	0.45924	2.1775	1.1004	2.3961	0.43313	0.90133	0.48055	2.0809	1.1095	2.3087	20
41	.41760	.90863	.45960	.1758	.1005	.3946	.43340	.90120	.48091	.0794	.1096	.3073	19
42	.41787	.90851	.45995	.1741	.1007	.3931	.43366	.90108	.48127	.0778	.1098	.3059	18
43	.41813	.90839	.46030	.1725	.1008	.3916	.43392	.90095	.48162	.0763	.1099	.3046	17
44	.41839	.90826	.46065	.1708	.1010	.3901	.43418	.90082	.48198	.0747	.1101	.3032	16
45	0.41866	0.90814	0.46101	2.1692	1.1011	2.3886	0.43444	0.90070	0.48234	2.0732	1.1102	2.3018	15
46	.41892	.90802	.46136	.1675	.1013	.3871	.43471	.90057	.48270	.0717	.1104	.3004	14
47	.41919	.90790	.46171	.1658	.1014	.3856	.43497	.90044	.48306	.0701	.1106	.2990	13
48	.41945	.90778	.46206	.1642	.1016	.3841	.43523	.90032	.48342	.0686	.1107	.2976	12
49	.41972	.90765	.46242	.1625	.1017	.3826	.43549	.90019	.48378	.0671	.1109	.2962	11
50	0.41998	0.90753	0.46277	2.1609	1.1019	2.3811	0.43575	0.90006	0.48414	2.0655	1.1110	2.2949	10
51	.42024	.90741	.46312	.1592	.1020	.3796	.43602	.89994	.48449	.0640	.1112	.2935	9
52	.42051	.90729	.46348	.1576	.1022	.3781	.43628	.89981	.48485	.0625	.1113	.2921	8
53	.42077	.90717	.46383	.1559	.1023	.3766	.43654	.89968	.48521	.0609	.1115	.2907	7
54	.42103	.90704	.46418	.1543	.1025	.3751	.43680	.89956	.48557	.0594	.1116	.2894	6
55	0.42130	0.90692	0.46454	2.1527	1.1026	2.3736	0.43706	0.89943	0.48593	2.0579	1.1118	2.2880	5
56	.42156	.90680	.46489	.1510	.1028	.3721	.43732	.89930	.48629	.0564	.1120	.2866	4
57	.42183	.90668	.46524	.1494	.1029	.3706	.43759	.89918	.48665	.0548	.1121	.2853	3
58	.42209	.90655	.46560	.1478	.1031	.3691	.43785	.89905	.48701	.0533	.1123	.2839	2
59	.42235	.90643	.46595	.1461	.1032	.3677	.43811	.89892	.48737	.0518	.1124	.2825	1
60	0.42262	0.90631	0.46631	2.1445	1.1034	2.3662	0.43837	0.89879	0.48773	2.0503	1.1126	2.2812	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
114°						65°	115°					64°	

NATURAL TRIGONOMETRIC FUNCTIONS

26°						153°	27°						152°
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.43837	0.89879	0.48773	2.0503	1.1126	2.2812	0.45399	0.89101	0.50952	1.9626	1.1223	2.2027	60
1	.43863	.89867	.48809	.0488	.1127	.2798	.45425	.89087	.50989	.9612	.1225	.2014	59
2	.43889	.89854	.48845	.0473	.1129	.2784	.45451	.89074	.51026	.9598	.1226	.2002	58
3	.43915	.89841	.48881	.0458	.1131	.2771	.45477	.89061	.51062	.9584	.1228	.1989	57
4	.43942	.89828	.48917	.0443	.1132	.2757	.45503	.89048	.51099	.9570	.1230	.1977	56
5	0.43968	0.89815	0.48953	2.0427	1.1134	2.2744	0.45528	0.89034	0.51136	1.9556	1.1231	2.1964	55
6	.43994	.89803	.48989	.0412	.1135	.2730	.45554	.89021	.51172	.9542	.1233	.1952	54
7	.44020	.89790	.49025	.0397	.1137	.2717	.45580	.89008	.51209	.9528	.1235	.1939	53
8	.44046	.89777	.49062	.0382	.1139	.2703	.45606	.88995	.51246	.9514	.1237	.1927	52
9	.44072	.89764	.49098	.0367	.1140	.2690	.45632	.88981	.51283	.9500	.1238	.1914	51
10	0.44098	0.89751	0.49134	2.0352	1.1142	2.2676	0.45658	0.88968	0.51319	1.9486	1.1240	2.1902	50
11	.44124	.89739	.49170	.0338	.1143	.2663	.45684	.88955	.51356	.9472	.1242	.1889	49
12	.44150	.89726	.49206	.0323	.1145	.2650	.45710	.88942	.51393	.9458	.1243	.1877	48
13	.44177	.89713	.49242	.0308	.1147	.2636	.45736	.88928	.51430	.9444	.1245	.1865	47
14	.44203	.89700	.49278	.0293	.1148	.2623	.45761	.88915	.51466	.9430	.1247	.1852	46
15	0.44229	0.89687	0.49314	2.0278	1.1150	2.2610	0.45787	0.88902	0.51503	1.9416	1.1248	2.1840	45
16	.44255	.89674	.49351	.0263	.1151	.2596	.45813	.88888	.51540	.9402	.1250	.1828	44
17	.44281	.89661	.49387	.0248	.1153	.2583	.45839	.88875	.51577	.9388	.1252	.1815	43
18	.44307	.89649	.49423	.0233	.1155	.2570	.45865	.88862	.51614	.9375	.1253	.1803	42
19	.44333	.89636	.49459	.0219	.1156	.2556	.45891	.88848	.51651	.9361	.1255	.1791	41
20	0.44359	0.89623	0.49495	2.0204	1.1158	2.2543	0.45917	0.88835	0.51687	1.9347	1.1257	2.1778	40
21	.44385	.89610	.49532	.0189	.1159	.2530	.45942	.88822	.51724	.9333	.1258	.1766	39
22	.44411	.89597	.49568	.0174	.1161	.2517	.45968	.88808	.51761	.9319	.1260	.1754	38
23	.44437	.89584	.49604	.0159	.1163	.2503	.45994	.88795	.51798	.9306	.1262	.1742	37
24	.44463	.89571	.49640	.0145	.1164	.2490	.46020	.88781	.51835	.9292	.1264	.1730	36
25	0.44489	0.89558	0.49677	2.0130	1.1166	2.2477	0.46046	0.88768	0.51872	1.9278	1.1265	2.1717	35
26	.44516	.89545	.49713	.0115	.1167	.2464	.46072	.88755	.51909	.9264	.1267	.1705	34
27	.44542	.89532	.49749	.0101	.1169	.2451	.46097	.88741	.51946	.9251	.1269	.1693	33
28	.44568	.89519	.49785	.0086	.1171	.2438	.46123	.88728	.51983	.9237	.1270	.1681	32
29	.44594	.89506	.49822	.0071	.1172	.2425	.46149	.88714	.52020	.9223	.1272	.1669	31
30	0.44620	0.89493	0.49858	2.0057	1.1174	2.2411	0.46175	0.88701	0.52057	1.9210	1.1274	2.1657	30
31	.44646	.89480	.49894	.0042	.1176	.2398	.46201	.88688	.52094	.9196	.1275	.1645	29
32	.44672	.89467	.49931	.0028	.1177	.2385	.46226	.88674	.52131	.9182	.1277	.1633	28
33	.44698	.89454	.49967	.0013	.1179	.2372	.46252	.88661	.52168	.9169	.1279	.1620	27
34	.44724	.89441	.50003	1.9998	.1180	.2359	.46278	.88647	.52205	.9155	.1281	.1608	26
35	0.44750	0.89428	0.50040	1.9984	1.1182	2.2346	0.46304	0.88634	0.52242	1.9142	1.1282	2.1596	25
36	.44776	.89415	.50076	.9969	.1184	.2333	.46330	.88620	.52279	.9128	.1284	.1584	24
37	.44802	.89402	.50113	.9955	.1185	.2320	.46355	.88607	.52316	.9115	.1286	.1572	23
38	.44828	.89389	.50149	.9940	.1187	.2307	.46381	.88593	.52353	.9101	.1287	.1560	22
39	.44854	.89376	.50185	.9926	.1189	.2294	.46407	.88580	.52390	.9088	.1289	.1548	21
40	0.44880	0.89363	0.50222	1.9912	1.1190	2.2282	0.46433	0.88566	0.52427	1.9074	1.1291	2.1536	20
41	.44906	.89350	.50258	.9897	.1192	.2269	.46458	.88553	.52464	.9061	.1293	.1525	19
42	.44932	.89337	.50295	.9883	.1193	.2256	.46484	.88539	.52501	.9047	.1294	.1513	18
43	.44958	.89324	.50331	.9868	.1195	.2243	.46510	.88526	.52538	.9034	.1296	.1501	17
44	.44984	.89311	.50368	.9854	.1197	.2230	.46536	.88512	.52575	.9020	.1298	.1489	16
45	0.45010	0.89298	0.50404	1.9840	1.1198	2.2217	0.46561	0.88499	0.52612	1.9007	1.1299	2.1477	15
46	.45036	.89285	.50441	.9825	.1200	.2204	.46587	.88485	.52650	.8993	.1301	.1465	14
47	.45062	.89272	.50477	.9811	.1202	.2192	.46613	.88472	.52687	.8980	.1303	.1453	13
48	.45088	.89258	.50514	.9797	.1203	.2179	.46639	.88458	.52724	.8967	.1305	.1441	12
49	.45114	.89245	.50550	.9782	.1205	.2166	.46664	.88444	.52761	.8953	.1306	.1430	11
50	0.45140	0.89232	0.50587	1.9768	1.1207	2.2153	0.46690	0.88431	0.52798	1.8940	1.1308	2.1418	10
51	.45166	.89219	.50623	.9754	.1208	.2141	.46716	.88417	.52836	.8927	.1310	.1406	9
52	.45191	.89206	.50660	.9739	.1210	.2128	.46741	.88404	.52873	.8913	.1312	.1394	8
53	.45217	.89193	.50696	.9725	.1212	.2115	.46767	.88390	.52910	.8900	.1313	.1382	7
54	.45243	.89180	.50733	.9711	.1213	.2103	.46793	.88376	.52947	.8887	.1315	.1371	6
55	0.45269	0.89166	0.50769	1.9697	1.1215	2.2090	0.46819	0.88363	0.52984	1.8873	1.1317	2.1359	5
56	.45295	.89153	.50806	.9683	.1217	.2077	.46844	.88349	.53022	.8860	.1319	.1347	4
57	.45321	.89140	.50843	.9668	.1218	.2065	.46870	.88336	.53059	.8847	.1320	.1335	3
58	.45347	.89127	.50879	.9654	.1220	.2052	.46896	.88322	.53096	.8834	.1322	.1324	2
59	.45373	.89114	.50916	.9640	.1222	.2039	.46921	.88308	.53134	.8820	.1324	.1312	1
60	0.45399	0.89101	0.50952	1.9626	1.1223	2.2027	0.46947	0.88295	0.53171	1.8807	1.1326	2.1300	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
116°						63°	117°						62°

NATURAL TRIGONOMETRIC FUNCTIONS

28°						151°	29°					150°	
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.46947	0.88295	0.53171	1.8807	1.1326	2.1300	0.48481	0.87462	0.55431	1.8040	1.1433	2.0627	60
1	.46973	.88281	.53208	.8794	.1327	.1289	.48506	.87448	.55469	.8028	.1435	.0616	59
2	.46998	.88267	.53245	.8781	.1329	.1277	.48532	.87434	.55507	.8016	.1437	.0605	58
3	.47024	.88254	.53283	.8768	.1331	.1266	.48557	.87420	.55545	.8003	.1439	.0594	57
4	.47050	.88240	.53320	.8754	.1333	.1254	.48583	.87405	.55583	.7991	.1441	.0583	56
5	0.47075	0.88226	0.53358	1.8741	1.1334	2.1242	0.48608	0.87391	0.55621	1.7979	1.1443	2.0573	55
6	.47101	.88213	.53395	.8728	.1336	.1231	.48633	.87377	.55659	.7966	.1445	.0562	54
7	.47127	.88199	.53432	.8715	.1338	.1219	.48659	.87363	.55697	.7954	.1446	.0551	53
8	.47152	.88185	.53470	.8702	.1340	.1208	.48684	.87349	.55735	.7942	.1448	.0540	52
9	.47178	.88171	.53507	.8689	.1341	.1196	.48710	.87335	.55774	.7930	.1450	.0530	51
10	0.47204	0.88158	0.53545	1.8676	1.1343	2.1185	0.48735	0.87320	0.55812	1.7917	1.1452	2.0519	50
11	.47229	.88144	.53582	.8663	.1345	.1173	.48760	.87306	.55850	.7905	.1454	.0508	49
12	.47255	.88130	.53619	.8650	.1347	.1162	.48786	.87292	.55888	.7893	.1456	.0498	48
13	.47281	.88117	.53657	.8637	.1349	.1150	.48811	.87278	.55926	.7881	.1458	.0487	47
14	.47306	.88103	.53694	.8624	.1350	.1139	.48837	.87264	.55964	.7868	.1459	.0476	46
15	0.47332	0.88089	0.53732	1.8611	1.1352	2.1127	0.48862	0.87250	0.56003	1.7856	1.1461	2.0466	45
16	.47357	.88075	.53769	.8598	.1354	.1116	.48887	.87235	.56041	.7844	.1463	.0455	44
17	.47383	.88061	.53807	.8585	.1356	.1104	.48913	.87221	.56079	.7832	.1465	.0444	43
18	.47409	.88048	.53844	.8572	.1357	.1093	.48938	.87207	.56117	.7820	.1467	.0434	42
19	.47434	.88034	.53882	.8559	.1359	.1082	.48964	.87193	.56156	.7808	.1469	.0423	41
20	0.47460	0.88020	0.53919	1.8546	1.1361	2.1070	0.48989	0.87178	0.56194	1.7795	1.1471	2.0413	40
21	.47486	.88006	.53957	.8533	.1363	.1059	.49014	.87164	.56232	.7783	.1473	.0402	39
22	.47511	.87992	.53995	.8520	.1365	.1048	.49040	.87150	.56270	.7771	.1474	.0392	38
23	.47537	.87979	.54032	.8507	.1366	.1036	.49065	.87136	.56309	.7759	.1476	.0381	37
24	.47562	.87965	.54070	.8495	.1368	.1025	.49090	.87121	.56347	.7747	.1478	.0370	36
25	0.47588	0.87951	0.54107	1.8482	1.1370	2.1014	0.49116	0.87107	0.56385	1.7735	1.1480	2.0360	35
26	.47613	.87937	.54145	.8469	.1372	.1002	.49141	.87093	.56424	.7723	.1482	.0349	34
27	.47639	.87923	.54183	.8456	.1373	.0991	.49166	.87078	.56462	.7711	.1484	.0339	33
28	.47665	.87909	.54220	.8443	.1375	.0980	.49192	.87064	.56500	.7699	.1486	.0329	32
29	.47690	.87895	.54258	.8430	.1377	.0969	.49217	.87050	.56539	.7687	.1488	.0318	31
30	0.47716	0.87882	0.54295	1.8418	1.1379	2.0957	0.49242	0.87035	0.56577	1.7675	1.1489	2.0308	30
31	.47741	.87868	.54333	.8405	.1381	.0946	.49268	.87021	.56616	.7663	.1491	.0297	29
32	.47767	.87854	.54371	.8392	.1382	.0935	.49293	.87007	.56654	.7651	.1493	.0287	28
33	.47792	.87840	.54409	.8379	.1384	.0924	.49318	.86992	.56692	.7639	.1495	.0276	27
34	.47818	.87826	.54446	.8367	.1386	.0912	.49343	.86978	.56731	.7627	.1497	.0266	26
35	0.47844	0.87812	0.54484	1.8354	1.1388	2.0901	0.49369	0.86964	0.56769	1.7615	1.1499	2.0256	25
36	.47869	.87798	.54522	.8341	.1390	.0890	.49394	.86949	.56808	.7603	.1501	.0245	24
37	.47895	.87784	.54559	.8329	.1391	.0879	.49419	.86935	.56846	.7591	.1503	.0235	23
38	.47920	.87770	.54597	.8316	.1393	.0868	.49445	.86921	.56885	.7579	.1505	.0224	22
39	.47946	.87756	.54635	.8303	.1395	.0857	.49470	.86906	.56923	.7567	.1507	.0214	21
40	0.47971	0.87742	0.54673	1.8291	1.1397	2.0846	0.49495	0.86892	0.56962	1.7555	1.1508	2.0204	20
41	.47997	.87728	.54711	.8278	.1399	.0835	.49521	.86877	.57000	.7544	.1510	.0194	19
42	.48022	.87715	.54748	.8265	.1401	.0824	.49546	.86863	.57039	.7532	.1512	.0183	18
43	.48048	.87701	.54786	.8253	.1402	.0812	.49571	.86849	.57077	.7520	.1514	.0173	17
44	.48073	.87687	.54824	.8240	.1404	.0801	.49596	.86834	.57116	.7508	.1516	.0163	16
45	0.48099	0.87673	0.54862	1.8227	1.1406	2.0790	0.49622	0.86820	0.57155	1.7496	1.1518	2.0152	15
46	.48124	.87659	.54900	.8215	.1408	.0779	.49647	.86805	.57193	.7484	.1520	.0142	14
47	.48150	.87645	.54937	.8202	.1410	.0768	.49672	.86791	.57232	.7473	.1522	.0132	13
48	.48175	.87631	.54975	.8190	.1411	.0757	.49697	.86776	.57270	.7461	.1524	.0122	12
49	.48201	.87617	.55013	.8177	.1413	.0746	.49723	.86762	.57309	.7449	.1526	.0111	11
50	0.48226	0.87603	0.55051	1.8165	1.1415	2.0735	0.49748	0.86748	0.57348	1.7437	1.1528	2.0101	10
51	.48252	.87588	.55089	.8152	.1417	.0725	.49773	.86733	.57386	.7426	.1530	.0091	9
52	.48277	.87574	.55127	.8140	.1419	.0714	.49798	.86719	.57425	.7414	.1531	.0081	8
53	.48303	.87560	.55165	.8127	.1421	.0703	.49823	.86704	.57464	.7402	.1533	.0071	7
54	.48328	.87546	.55203	.8115	.1422	.0692	.49849	.86690	.57502	.7390	.1535	.0061	6
55	0.48354	0.87532	0.55241	1.8102	1.1424	2.0681	0.49874	0.86675	0.57541	1.7379	1.1537	2.0050	5
56	.48379	.87518	.55279	.8090	.1426	.0670	.49899	.86661	.57580	.7367	.1539	.0040	4
57	.48405	.87504	.55317	.8078	.1428	.0659	.49924	.86646	.57619	.7355	.1541	.0030	3
58	.48430	.87490	.55355	.8065	.1430	.0648	.49950	.86632	.57657	.7344	.1543	.0020	2
59	.48455	.87476	.55393	.8053	.1432	.0637	.49975	.86617	.57696	.7332	.1545	.0010	1
60	0.48481	0.87462	0.55431	1.8040	1.1433	2.0627	0.50000	0.86603	0.57735	1.7320	1.1547	2.0000	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
118°						61°	119°					60°	

NATURAL TRIGONOMETRIC FUNCTIONS

30°						149°	31°					148°	
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.50000	0.86603	0.57735	1.7320	1.1547	2.0000	0.51504	0.85717	0.60086	1.6643	1.1666	1.9416	60
1	.50025	.86588	.57774	.7309	.1549	1.9990	.51529	.85702	.60126	.6632	.1668	.9407	59
2	.50050	.86573	.57813	.7297	.1551	.9980	.51554	.85687	.60165	.6621	.1670	.9397	58
3	.50075	.86559	.57851	.7286	.1553	.9970	.51578	.85672	.60205	.6610	.1672	.9388	57
4	.50101	.86544	.57890	.7274	.1555	.9960	.51603	.85657	.60244	.6599	.1674	.9378	56
5	0.50126	0.86530	0.57929	1.7262	1.1557	1.9950	0.51628	0.85642	0.60284	1.6588	1.1676	1.9369	55
6	.50151	.86515	.57968	.7251	.1559	.9940	.51653	.85627	.60324	.6577	.1678	.9360	54
7	.50176	.86500	.58007	.7239	.1561	.9930	.51678	.85612	.60363	.6566	.1681	.9350	53
8	.50201	.86486	.58046	.7228	.1562	.9920	.51703	.85597	.60403	.6555	.1683	.9341	52
9	.50226	.86471	.58085	.7216	.1564	.9910	.51728	.85582	.60443	.6544	.1685	.9332	51
10	0.50252	0.86457	0.58123	1.7205	1.1566	1.9900	0.51753	0.85566	0.60483	1.6534	1.1687	1.9322	50
11	.50277	.86442	.58162	.7193	.1568	.9890	.51778	.85551	.60522	.6523	.1689	.9313	49
12	.50302	.86427	.58201	.7182	.1570	.9880	.51803	.85536	.60562	.6512	.1691	.9304	48
13	.50327	.86413	.58240	.7170	.1572	.9870	.51827	.85521	.60602	.6501	.1693	.9295	47
14	.50352	.86398	.58279	.7159	.1574	.9860	.51852	.85506	.60642	.6490	.1695	.9285	46
15	0.50377	0.86383	0.58318	1.7147	1.1576	1.9850	0.51877	0.85491	0.60681	1.6479	1.1697	1.9276	45
16	.50402	.86369	.58357	.7136	.1578	.9840	.51902	.85476	.60721	.6469	.1699	.9267	44
17	.50428	.86354	.58396	.7124	.1580	.9830	.51927	.85461	.60761	.6458	.1701	.9258	43
18	.50453	.86339	.58435	.7113	.1582	.9820	.51952	.85446	.60801	.6447	.1703	.9248	42
19	.50478	.86325	.58474	.7101	.1584	.9811	.51977	.85431	.60841	.6436	.1705	.9239	41
20	0.50503	0.86310	0.58513	1.7090	1.1586	1.9801	0.52002	0.85416	0.60881	1.6425	1.1707	1.9230	40
21	.50528	.86295	.58552	.7079	.1588	.9791	.52026	.85400	.60920	.6415	.1709	.9221	39
22	.50553	.86281	.58591	.7067	.1590	.9781	.52051	.85385	.60960	.6404	.1712	.9212	38
23	.50578	.86266	.58630	.7056	.1592	.9771	.52076	.85370	.61000	.6393	.1714	.9203	37
24	.50603	.86251	.58670	.7044	.1594	.9761	.52101	.85355	.61040	.6383	.1716	.9193	36
25	0.50628	0.86237	0.58709	1.7033	1.1596	1.9752	0.52126	0.85340	0.61080	1.6372	1.1718	1.9184	35
26	.50653	.86222	.58748	.7022	.1598	.9742	.52151	.85325	.61120	.6361	.1720	.9175	34
27	.50679	.86207	.58787	.7010	.1600	.9732	.52175	.85309	.61160	.6350	.1722	.9166	33
28	.50704	.86192	.58826	.6999	.1602	.9722	.52200	.85294	.61200	.6340	.1724	.9157	32
29	.50729	.86178	.58865	.6988	.1604	.9713	.52225	.85279	.61240	.6329	.1726	.9148	31
30	0.50754	0.86163	0.58904	1.6977	1.1606	1.9703	0.52250	0.85264	0.61280	1.6318	1.1728	1.9139	30
31	.50779	.86148	.58944	.6965	.1608	.9693	.52275	.85249	.61320	.6308	.1730	.9130	29
32	.50804	.86133	.58983	.6954	.1610	.9683	.52299	.85234	.61360	.6297	.1732	.9121	28
33	.50829	.86118	.59022	.6943	.1612	.9674	.52324	.85218	.61400	.6286	.1734	.9112	27
34	.50854	.86104	.59061	.6931	.1614	.9664	.52349	.85203	.61440	.6276	.1737	.9102	26
35	0.50879	0.86089	0.59100	1.6920	1.1616	1.9654	0.52374	0.85188	0.61480	1.6265	1.1739	1.9093	25
36	.50904	.86074	.59140	.6909	.1618	.9645	.52398	.85173	.61520	.6255	.1741	.9084	24
37	.50929	.86059	.59179	.6898	.1620	.9635	.52423	.85157	.61560	.6244	.1743	.9075	23
38	.50954	.86044	.59218	.6887	.1622	.9625	.52448	.85142	.61601	.6233	.1745	.9066	22
39	.50979	.86030	.59258	.6875	.1624	.9616	.52473	.85127	.61641	.6223	.1747	.9057	21
40	0.51004	0.86015	0.59297	1.6864	1.1626	1.9606	0.52498	0.85112	0.61681	1.6212	1.1749	1.9048	20
41	.51029	.86000	.59336	.6853	.1628	.9596	.52522	.85096	.61721	.6202	.1751	.9039	19
42	.51054	.85985	.59376	.6842	.1630	.9587	.52547	.85081	.61761	.6191	.1753	.9030	18
43	.51079	.85970	.59415	.6831	.1632	.9577	.52572	.85066	.61801	.6181	.1756	.9021	17
44	.51104	.85955	.59454	.6820	.1634	.9568	.52597	.85050	.61842	.6170	.1758	.9013	16
45	0.51129	0.85941	0.59494	1.6808	1.1636	1.9558	0.52621	0.85035	0.61882	1.6160	1.1760	1.9004	15
46	.51154	.85926	.59533	.6797	.1638	.9549	.52646	.85020	.61922	.6149	.1762	.8995	14
47	.51179	.85911	.59572	.6786	.1640	.9539	.52671	.85004	.61962	.6139	.1764	.8986	13
48	.51204	.85896	.59612	.6775	.1642	.9530	.52695	.84989	.62003	.6128	.1766	.8977	12
49	.51229	.85881	.59651	.6764	.1644	.9520	.52720	.84974	.62043	.6118	.1768	.8968	11
50	0.51254	0.85866	0.59691	1.6753	1.1646	1.9510	0.52745	0.84959	0.62083	1.6107	1.1770	1.8959	10
51	.51279	.85851	.59730	.6742	.1648	.9501	.52770	.84943	.62123	.6097	.1772	.8950	9
52	.51304	.85836	.59770	.6731	.1650	.9491	.52794	.84928	.62164	.6086	.1775	.8941	8
53	.51329	.85821	.59809	.6720	.1652	.9482	.52819	.84912	.62204	.6076	.1777	.8932	7
54	.51354	.85806	.59849	.6709	.1654	.9473	.52844	.84897	.62244	.6066	.1779	.8924	6
55	0.51379	0.85791	0.59888	1.6698	1.1656	1.9463	0.52868	0.84882	0.62285	1.6055	1.1781	1.8915	5
56	.51404	.85777	.59928	.6687	.1658	.9454	.52893	.84866	.62325	.6045	.1783	.8906	4
57	.51429	.85762	.59967	.6676	.1660	.9444	.52918	.84851	.62366	.6034	.1785	.8897	3
58	.51454	.85747	.60007	.6665	.1662	.9435	.52942	.84836	.62406	.6024	.1787	.8888	2
59	.51479	.85732	.60046	.6654	.1664	.9425	.52967	.84820	.62446	.6014	.1790	.8879	1
60	0.51504	0.85717	0.60086	1.6643	1.1666	1.9416	0.52992	0.84805	0.62487	1.6003	1.1792	1.8871	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
120°						59°	121°					58°	

NATURAL TRIGONOMETRIC FUNCTIONS

32°						147°	33°					146°	
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.52992	0.84805	0.62487	1.6003	1.1792	1.8871	0.54464	0.83867	0.64941	1.5399	1.1924	1.8361	60
1	.53016	.84789	.62527	.5993	.1794	.8862	.54488	.83851	.64982	.5389	.1926	.8352	59
2	.53041	.84774	.62568	.5983	.1796	.8853	.54513	.83835	.65023	.5379	.1928	.8344	58
3	.53066	.84758	.62608	.5972	.1798	.8844	.54537	.83819	.65065	.5369	.1930	.8336	57
4	.53090	.84743	.62649	.5962	.1800	.8836	.54561	.83804	.65106	.5359	.1933	.8328	56
5	0.53115	0.84728	0.62689	1.5952	1.1802	1.8827	0.54586	0.83788	0.65148	1.5350	1.1935	1.8320	55
6	.53140	.84712	.62730	.5941	.1805	.8818	.54610	.83772	.65189	.5340	.1937	.8311	54
7	.53164	.84697	.62770	.5931	.1807	.8809	.54634	.83756	.65231	.5330	.1939	.8303	53
8	.53189	.84681	.62811	.5921	.1809	.8801	.54659	.83740	.65272	.5320	.1942	.8295	52
9	.53214	.84666	.62851	.5910	.1811	.8792	.54683	.83724	.65314	.5311	.1944	.8287	51
10	0.53238	0.84650	0.62892	1.5900	1.1813	1.8783	0.54708	0.83708	0.65355	1.5301	1.1946	1.8279	50
11	.53263	.84635	.62933	.5890	.1815	.8775	.54732	.83692	.65397	.5291	.1948	.8271	49
12	.53288	.84619	.62973	.5880	.1818	.8766	.54756	.83676	.65438	.5282	.1951	.8263	48
13	.53312	.84604	.63014	.5869	.1820	.8757	.54781	.83660	.65480	.5272	.1953	.8255	47
14	.53337	.84588	.63055	.5859	.1822	.8749	.54805	.83644	.65521	.5262	.1955	.8246	46
15	0.53361	0.84573	0.63095	1.5849	1.1824	1.8740	0.54829	0.83629	0.65563	1.5252	1.1958	1.8238	45
16	.53386	.84557	.63136	.5839	.1826	.8731	.54854	.83613	.65604	.5243	.1960	.8230	44
17	.53411	.84542	.63177	.5829	.1828	.8723	.54878	.83597	.65646	.5233	.1962	.8222	43
18	.53435	.84526	.63217	.5818	.1831	.8714	.54902	.83581	.65688	.5223	.1964	.8214	42
19	.53460	.84511	.63258	.5808	.1833	.8706	.54926	.83565	.65729	.5214	.1967	.8206	41
20	0.53484	0.84495	0.63299	1.5798	1.1835	1.8697	0.54951	0.83549	0.65771	1.5204	1.1969	1.8198	40
21	.53509	.84479	.63339	.5788	.1837	.8688	.54975	.83533	.65813	.5195	.1971	.8190	39
22	.53533	.84464	.63380	.5778	.1839	.8680	.54999	.83517	.65854	.5185	.1974	.8182	38
23	.53558	.84448	.63421	.5768	.1841	.8671	.55024	.83501	.65896	.5175	.1976	.8174	37
24	.53583	.84433	.63462	.5757	.1844	.8663	.55048	.83485	.65938	.5166	.1978	.8166	36
25	0.53607	0.84417	0.63503	1.5747	1.1846	1.8654	0.55072	0.83469	0.65980	1.5156	1.1980	1.8158	35
26	.53632	.84402	.63543	.5737	.1848	.8646	.55097	.83453	.66021	.5147	.1983	.8150	34
27	.53656	.84386	.63584	.5727	.1850	.8637	.55121	.83437	.66063	.5137	.1985	.8142	33
28	.53681	.84370	.63625	.5717	.1852	.8629	.55145	.83421	.66105	.5127	.1987	.8134	32
29	.53705	.84355	.63666	.5707	.1855	.8620	.55169	.83405	.66147	.5118	.1990	.8126	31
30	0.53730	0.84339	0.63707	1.5697	1.1857	1.8611	0.55194	0.83388	0.66188	1.5108	1.1992	1.8118	30
31	.53754	.84323	.63748	.5687	.1859	.8603	.55218	.83372	.66230	.5099	.1994	.8110	29
32	.53779	.84308	.63789	.5677	.1861	.8595	.55242	.83356	.66272	.5089	.1997	.8102	28
33	.53803	.84292	.63830	.5667	.1863	.8586	.55266	.83340	.66314	.5080	.1999	.8094	27
34	.53828	.84276	.63871	.5657	.1866	.8578	.55291	.83324	.66356	.5070	.2001	.8086	26
35	0.53852	0.84261	0.63912	1.5646	1.1868	1.8569	0.55315	0.83308	0.66398	1.5061	1.2004	1.8078	25
36	.53877	.84245	.63953	.5636	.1870	.8561	.55339	.83292	.66440	.5051	.2006	.8070	24
37	.53901	.84229	.63994	.5626	.1872	.8552	.55363	.83276	.66482	.5042	.2008	.8062	23
38	.53926	.84214	.64035	.5616	.1874	.8544	.55388	.83260	.66524	.5032	.2010	.8054	22
39	.53950	.84198	.64076	.5606	.1877	.8535	.55412	.83244	.66566	.5023	.2013	.8047	21
40	0.53975	0.84182	0.64117	1.5596	1.1879	1.8527	0.55436	0.83228	0.66608	1.5013	1.2015	1.8039	20
41	.53999	.84167	.64158	.5586	.1881	.8519	.55460	.83211	.66650	.5004	.2017	.8031	19
42	.54024	.84151	.64199	.5577	.1883	.8510	.55484	.83195	.66692	.4994	.2020	.8023	18
43	.54048	.84135	.64240	.5567	.1886	.8502	.55509	.83179	.66734	.4985	.2022	.8015	17
44	.54073	.84120	.64281	.5557	.1888	.8493	.55533	.83163	.66776	.4975	.2024	.8007	16
45	0.54097	0.84104	0.64322	1.5547	1.1890	1.8485	0.55557	0.83147	0.66818	1.4966	1.2027	1.7999	15
46	.54122	.84088	.64363	.5537	.1892	.8477	.55581	.83131	.66860	.4957	.2029	.7992	14
47	.54146	.84072	.64404	.5527	.1894	.8468	.55605	.83115	.66902	.4947	.2031	.7984	13
48	.54171	.84057	.64446	.5517	.1897	.8460	.55629	.83098	.66944	.4938	.2034	.7976	12
49	.54195	.84041	.64487	.5507	.1899	.8452	.55654	.83082	.66986	.4928	.2036	.7968	11
50	0.54220	0.84025	0.64528	1.5497	1.1901	1.8443	0.55678	0.83066	0.67028	1.4919	1.2039	1.7960	10
51	.54244	.84009	.64569	.5487	.1903	.8435	.55702	.83050	.67071	.4910	.2041	.7953	9
52	.54268	.83993	.64610	.5477	.1906	.8427	.55726	.83034	.67113	.4900	.2043	.7945	8
53	.54293	.83978	.64652	.5467	.1908	.8418	.55750	.83017	.67155	.4891	.2046	.7937	7
54	.54317	.83962	.64693	.5458	.1910	.8410	.55774	.83001	.67197	.4881	.2048	.7929	6
55	0.54342	0.83946	0.64734	1.5448	1.1912	1.8402	0.55799	0.82985	0.67239	1.4872	1.2050	1.7921	5
56	.54366	.83930	.64775	.5438	.1915	.8394	.55823	.82969	.67282	.4863	.2053	.7914	4
57	.54391	.83914	.64817	.5428	.1917	.8385	.55847	.82952	.67324	.4853	.2055	.7906	3
58	.54415	.83899	.64858	.5418	.1919	.8377	.55871	.82936	.67366	.4844	.2057	.7898	2
59	.54439	.83883	.64899	.5408	.1921	.8369	.55895	.82920	.67408	.4835	.2060	.7891	1
60	0.54464	0.83867	0.64941	1.5399	1.1922	1.8361	0.55919	0.82904	0.67451	1.4826	1.2062	1.7883	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
122°						57°	123°					56°	

NATURAL TRIGONOMETRIC FUNCTIONS

34°						145°	35°						144°
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.55919	0.82904	0.67451	1.4826	1.2062	1.7883	0.57358	0.81915	0.70021	1.4281	1.2208	1.7434	60
1	.55943	.82887	.67493	.4816	.2064	.7875	.57381	.81898	.70064	.4273	.2210	.7427	59
2	.55967	.82871	.67535	.4807	.2067	.7867	.57405	.81882	.70107	.4264	.2213	.7420	58
3	.55992	.82855	.67578	.4798	.2069	.7860	.57429	.81865	.70151	.4255	.2215	.7413	57
4	.56016	.82839	.67620	.4788	.2072	.7852	.57453	.81848	.70194	.4246	.2218	.7405	56
5	0.56040	0.82822	0.67663	1.4779	1.2074	1.7844	0.57477	0.81832	0.70238	1.4237	1.2220	1.7398	55
6	.56064	.82806	.67705	.4770	.2076	.7837	.57500	.81815	.70281	.4228	.2223	.7391	54
7	.56088	.82790	.67747	.4761	.2079	.7829	.57524	.81798	.70325	.4220	.2225	.7384	53
8	.56112	.82773	.67790	.4751	.2081	.7821	.57548	.81781	.70368	.4211	.2228	.7377	52
9	.56136	.82757	.67832	.4742	.2083	.7814	.57572	.81765	.70412	.4202	.2230	.7369	51
10	0.56160	0.82741	0.67875	1.4733	1.2086	1.7806	0.57596	0.81748	0.70455	1.4193	1.2233	1.7362	50
11	.56184	.82724	.67917	.4724	.2088	.7798	.57619	.81731	.70499	.4185	.2235	.7355	49
12	.56208	.82708	.67960	.4714	.2091	.7791	.57643	.81714	.70542	.4176	.2238	.7348	48
13	.56232	.82692	.68002	.4705	.2093	.7783	.57667	.81698	.70586	.4167	.2240	.7341	47
14	.56256	.82675	.68045	.4696	.2095	.7776	.57691	.81681	.70629	.4158	.2243	.7334	46
15	0.56280	0.82659	0.68087	1.4687	1.2098	1.7768	0.57714	0.81664	0.70673	1.4150	1.2245	1.7327	45
16	.56304	.82643	.68130	.4678	.2100	.7760	.57738	.81647	.70717	.4141	.2248	.7319	44
17	.56328	.82626	.68173	.4669	.2103	.7753	.57762	.81630	.70760	.4132	.2250	.7312	43
18	.56353	.82610	.68215	.4659	.2105	.7745	.57786	.81614	.70804	.4123	.2253	.7305	42
19	.56377	.82593	.68258	.4650	.2107	.7738	.57809	.81597	.70848	.4115	.2255	.7298	41
20	0.56401	0.82577	0.68301	1.4641	1.2110	1.7730	0.57833	0.81580	0.70891	1.4106	1.2258	1.7291	40
21	.56425	.82561	.68343	.4632	.2112	.7723	.57857	.81563	.70935	.4097	.2260	.7284	39
22	.56449	.82544	.68386	.4623	.2115	.7715	.57881	.81546	.70979	.4089	.2263	.7277	38
23	.56473	.82528	.68429	.4614	.2117	.7708	.57904	.81530	.71022	.4080	.2265	.7270	37
24	.56497	.82511	.68471	.4605	.2119	.7700	.57928	.81513	.71066	.4071	.2268	.7263	36
25	0.56521	0.82495	0.68514	1.4595	1.2122	1.7693	0.57952	0.81496	0.71110	1.4063	1.2270	1.7256	35
26	.56545	.82478	.68557	.4586	.2124	.7685	.57975	.81479	.71154	.4054	.2273	.7249	34
27	.56569	.82462	.68600	.4577	.2127	.7678	.57999	.81462	.71198	.4045	.2276	.7242	33
28	.56593	.82445	.68642	.4568	.2129	.7670	.58023	.81445	.71241	.4037	.2278	.7234	32
29	.56617	.82429	.68685	.4559	.2132	.7663	.58047	.81428	.71285	.4028	.2281	.7227	31
30	0.56641	0.82413	0.68728	1.4550	1.2134	1.7655	0.58070	0.81411	0.71329	1.4019	1.2283	1.7220	30
31	.56664	.82396	.68771	.4541	.2136	.7648	.58094	.81395	.71373	.4011	.2286	.7213	29
32	.56688	.82380	.68814	.4532	.2139	.7640	.58118	.81378	.71417	.4002	.2288	.7206	28
33	.56712	.82363	.68857	.4523	.2141	.7633	.58141	.81361	.71461	.3994	.2291	.7199	27
34	.56736	.82347	.68899	.4514	.2144	.7625	.58165	.81344	.71505	.3985	.2293	.7192	26
35	0.56760	0.82330	0.68942	1.4505	1.2146	1.7618	0.58189	0.81327	0.71549	1.3976	1.2296	1.7185	25
36	.56784	.82314	.68985	.4496	.2149	.7610	.58212	.81310	.71593	.3968	.2298	.7178	24
37	.56808	.82297	.69028	.4487	.2151	.7603	.58236	.81293	.71637	.3959	.2301	.7171	23
38	.56832	.82280	.69071	.4478	.2153	.7596	.58259	.81276	.71681	.3951	.2304	.7164	22
39	.56856	.82264	.69114	.4469	.2156	.7588	.58283	.81259	.71725	.3942	.2306	.7157	21
40	0.56880	0.82247	0.69157	1.4460	1.2158	1.7581	0.58307	0.81242	0.71769	1.3933	1.2309	1.7151	20
41	.56904	.82231	.69200	.4451	.2161	.7573	.58330	.81225	.71813	.3925	.2311	.7144	19
42	.56928	.82214	.69243	.4442	.2163	.7566	.58354	.81208	.71857	.3916	.2314	.7137	18
43	.56952	.82198	.69286	.4433	.2166	.7559	.58378	.81191	.71901	.3908	.2316	.7130	17
44	.56976	.82181	.69329	.4424	.2168	.7551	.58401	.81174	.71945	.3899	.2319	.7123	16
45	0.57000	0.82165	0.69372	1.4415	1.2171	1.7544	0.58425	0.81157	0.71990	1.3891	1.2322	1.7116	15
46	.57023	.82148	.69415	.4406	.2173	.7537	.58448	.81140	.72034	.3882	.2324	.7109	14
47	.57047	.82131	.69459	.4397	.2175	.7529	.58472	.81123	.72078	.3874	.2327	.7102	13
48	.57071	.82115	.69502	.4388	.2178	.7522	.58496	.81106	.72122	.3865	.2329	.7095	12
49	.57095	.82098	.69545	.4379	.2180	.7514	.58519	.81089	.72166	.3857	.2332	.7088	11
50	0.57119	0.82082	0.69588	1.4370	1.2183	1.7507	0.58543	0.81072	0.72211	1.3848	1.2335	1.7081	10
51	.57143	.82065	.69631	.4361	.2185	.7500	.58566	.81055	.72255	.3840	.2337	.7075	9
52	.57167	.82048	.69674	.4352	.2188	.7493	.58590	.81038	.72299	.3831	.2340	.7068	8
53	.57191	.82032	.69718	.4343	.2190	.7485	.58614	.81021	.72344	.3823	.2342	.7061	7
54	.57214	.82015	.69761	.4335	.2193	.7478	.58637	.81004	.72388	.3814	.2345	.7054	6
55	0.57238	0.81998	0.69804	1.4326	1.2195	1.7471	0.58661	0.80987	0.72432	1.3806	1.2348	1.7047	5
56	.57262	.81982	.69847	.4317	.2198	.7463	.58684	.80970	.72477	.3797	.2350	.7040	4
57	.57286	.81965	.69891	.4308	.2200	.7456	.58708	.80953	.72521	.3789	.2353	.7033	3
58	.57310	.81948	.69934	.4299	.2203	.7449	.58731	.80936	.72565	.3781	.2355	.7027	2
59	.57334	.81932	.69977	.4290	.2205	.7442	.58755	.80919	.72610	.3772	.2358	.7020	1
60	0.57358	0.81915	0.70021	1.4281	1.2208	1.7434	0.58778	0.80902	0.72654	1.3764	1.2361	1.7013	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
124°						55°	125°						54°

NATURAL TRIGONOMETRIC FUNCTIONS

36°						143°	37°					142°	
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.58778	0.80902	0.72654	1.3764	1.2361	1.7013	0.60181	0.79863	0.75355	1.3270	1.2521	1.6616	60
1	.58802	.80885	.72699	.3755	.2363	.7006	.60205	.79846	.75401	.3262	.2524	.6610	59
2	.58825	.80867	.72743	.3747	.2366	.6999	.60228	.79828	.75447	.3254	.2527	.6603	58
3	.58849	.80850	.72788	.3738	.2368	.6993	.60251	.79811	.75492	.3246	.2530	.6597	57
4	.58873	.80833	.72832	.3730	.2371	.6986	.60274	.79793	.75538	.3238	.2532	.6591	56
5	0.58896	0.80816	0.72877	1.3722	1.2374	1.6979	0.60298	0.79776	0.75584	1.3230	1.2535	1.6584	55
6	.58920	.80799	.72921	.3713	.2376	.6972	.60320	.79758	.75629	.3222	.2538	.6578	54
7	.58943	.80782	.72966	.3705	.2379	.6965	.60344	.79741	.75675	.3214	.2541	.6572	53
8	.58967	.80765	.73010	.3697	.2382	.6959	.60367	.79723	.75721	.3206	.2543	.6565	52
9	.58990	.80747	.73055	.3688	.2384	.6952	.60390	.79706	.75767	.3198	.2546	.6559	51
10	0.59014	0.80730	0.73100	1.3680	1.2387	1.6945	0.60413	0.79688	0.75812	1.3190	1.2549	1.6552	50
11	.59037	.80713	.73144	.3672	.2389	.6938	.60437	.79670	.75858	.3182	.2552	.6546	49
12	.59060	.80696	.73189	.3663	.2392	.6932	.60460	.79653	.75904	.3174	.2554	.6540	48
13	.59084	.80679	.73234	.3655	.2395	.6925	.60483	.79635	.75950	.3166	.2557	.6533	47
14	.59107	.80662	.73278	.3647	.2397	.6918	.60506	.79618	.75996	.3159	.2560	.6527	46
15	0.59131	0.80644	0.73323	1.3638	1.2400	1.6912	0.60529	0.79600	0.76042	1.3151	1.2563	1.6521	45
16	.59154	.80627	.73368	.3630	.2403	.6905	.60552	.79582	.76088	.3143	.2565	.6514	44
17	.59178	.80610	.73412	.3622	.2405	.6898	.60576	.79565	.76134	.3135	.2568	.6508	43
18	.59201	.80593	.73457	.3613	.2408	.6891	.60599	.79547	.76179	.3127	.2571	.6502	42
19	.59225	.80576	.73502	.3605	.2411	.6885	.60622	.79530	.76225	.3119	.2574	.6496	41
20	0.59248	0.80558	0.73547	1.3597	1.2413	1.6878	0.60645	0.79512	0.76271	1.3111	1.2577	1.6489	40
21	.59272	.80541	.73592	.3588	.2416	.6871	.60668	.79494	.76317	.3103	.2579	.6483	39
22	.59295	.80524	.73637	.3580	.2419	.6865	.60691	.79477	.76364	.3095	.2582	.6477	38
23	.59318	.80507	.73681	.3572	.2421	.6858	.60714	.79459	.76410	.3087	.2585	.6470	37
24	.59342	.80489	.73726	.3564	.2424	.6851	.60737	.79441	.76456	.3079	.2588	.6464	36
25	0.59365	0.80472	0.73771	1.3555	1.2427	1.6845	0.60761	0.79424	0.76502	1.3071	1.2591	1.6458	35
26	.59389	.80455	.73816	.3547	.2429	.6838	.60784	.79406	.76548	.3064	.2593	.6452	34
27	.59412	.80437	.73861	.3539	.2432	.6831	.60807	.79388	.76594	.3056	.2596	.6445	33
28	.59435	.80420	.73906	.3531	.2435	.6825	.60830	.79371	.76640	.3048	.2599	.6439	32
29	.59459	.80403	.73951	.3522	.2437	.6818	.60853	.79353	.76686	.3040	.2602	.6433	31
30	0.59482	0.80386	0.73996	1.3514	1.2440	1.6812	0.60876	0.79335	0.76733	1.3032	1.2605	1.6427	30
31	.59506	.80368	.74041	.3506	.2443	.6805	.60899	.79318	.76779	.3024	.2607	.6420	29
32	.59529	.80351	.74086	.3498	.2445	.6798	.60922	.79300	.76825	.3016	.2610	.6414	28
33	.59552	.80334	.74131	.3489	.2448	.6792	.60945	.79282	.76871	.3009	.2613	.6408	27
34	.59576	.80316	.74176	.3481	.2451	.6785	.60968	.79264	.76918	.3001	.2616	.6402	26
35	0.59599	0.80299	0.74221	1.3473	1.2453	1.6779	0.60991	0.79247	0.76964	1.2993	1.2619	1.6396	25
36	.59622	.80282	.74266	.3465	.2456	.6772	.61014	.79229	.77010	.2985	.2622	.6389	24
37	.59646	.80264	.74312	.3457	.2459	.6766	.61037	.79211	.77057	.2977	.2624	.6383	23
38	.59669	.80247	.74357	.3449	.2461	.6759	.61061	.79193	.77103	.2970	.2627	.6377	22
39	.59692	.80230	.74402	.3440	.2464	.6752	.61084	.79176	.77149	.2962	.2630	.6371	21
40	0.59716	0.80212	0.74447	1.3432	1.2467	1.6746	0.61107	0.79158	0.77196	1.2954	1.2633	1.6365	20
41	.59739	.80195	.74492	.3424	.2470	.6739	.61130	.79140	.77242	.2946	.2636	.6359	19
42	.59762	.80177	.74538	.3416	.2472	.6733	.61153	.79122	.77289	.2938	.2639	.6352	18
43	.59786	.80160	.74583	.3408	.2475	.6726	.61176	.79104	.77335	.2931	.2641	.6346	17
44	.59809	.80143	.74628	.3400	.2478	.6720	.61199	.79087	.77382	.2923	.2644	.6340	16
45	0.59832	0.80125	0.74673	1.3392	1.2480	1.6713	0.61222	0.79069	0.77428	1.2915	1.2647	1.6334	15
46	.59856	.80108	.74719	.3383	.2483	.6707	.61245	.79051	.77475	.2907	.2650	.6328	14
47	.59879	.80090	.74764	.3375	.2486	.6700	.61268	.79033	.77521	.2900	.2653	.6322	13
48	.59902	.80073	.74809	.3367	.2488	.6694	.61290	.79015	.77568	.2892	.2656	.6316	12
49	.59926	.80056	.74855	.3359	.2491	.6687	.61314	.78998	.77614	.2884	.2659	.6309	11
50	0.59949	0.80038	0.74900	1.3351	1.2494	1.6681	0.61337	0.78980	0.77661	1.2876	1.2661	1.6303	10
51	.59972	.80021	.74946	.3343	.2497	.6674	.61360	.78962	.77708	.2869	.2664	.6297	9
52	.59995	.80003	.74991	.3335	.2499	.6668	.61383	.78944	.77754	.2861	.2667	.6291	8
53	.60019	.79986	.75037	.3327	.2502	.6661	.61405	.78926	.77801	.2853	.2670	.6285	7
54	.60042	.79968	.75082	.3319	.2505	.6655	.61428	.78908	.77848	.2845	.2673	.6279	6
55	0.60065	0.79951	0.75128	1.3311	1.2508	1.6648	0.61451	0.78890	0.77895	1.2838	1.2676	1.6273	5
56	.60088	.79933	.75173	.3303	.2510	.6642	.61474	.78873	.77941	.2830	.2679	.6267	4
57	.60112	.79916	.75219	.3294	.2513	.6636	.61497	.78855	.77988	.2822	.2681	.6261	3
58	.60135	.79898	.75264	.3286	.2516	.6629	.61520	.78837	.78035	.2815	.2684	.6255	2
59	.60158	.79881	.75310	.3278	.2519	.6623	.61543	.78819	.78082	.2807	.2687	.6249	1
60	0.60181	0.79863	0.75355	1.3270	1.2521	1.6616	0.61566	0.78801	0.78128	1.2799	1.2690	1.6243	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
126°						53°	127°					52°	

NATURAL TRIGONOMETRIC FUNCTIONS

38°						141°	39°						140°
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.61566	0.78801	0.78128	1.2799	1.2690	1.6243	0.62932	0.77715	0.80978	1.2349	1.2867	1.5890	60
1	.61589	.78783	.78175	.2792	.2693	.6237	.62955	.77696	.81026	.2342	.2871	.5884	59
2	.61612	.78765	.78222	.2784	.2696	.6231	.62977	.77678	.81075	.2334	.2874	.5879	58
3	.61635	.78747	.78269	.2776	.2699	.6224	.63000	.77660	.81123	.2327	.2877	.5873	57
4	.61658	.78729	.78316	.2769	.2702	.6218	.63022	.77641	.81171	.2320	.2880	.5867	56
5	0.61681	0.78711	0.78363	1.2761	1.2705	1.6212	0.63045	0.77623	0.81219	1.2312	1.2883	1.5862	55
6	.61703	.78693	.78410	.2753	.2707	.6206	.63067	.77605	.81268	.2305	.2886	.5856	54
7	.61726	.78675	.78457	.2746	.2710	.6200	.63090	.77586	.81316	.2297	.2889	.5850	53
8	.61749	.78657	.78504	.2738	.2713	.6194	.63113	.77568	.81364	.2290	.2892	.5845	52
9	.61772	.78640	.78551	.2730	.2716	.6188	.63135	.77549	.81413	.2283	.2895	.5839	51
10	0.61795	0.78622	0.78598	1.2723	1.2719	1.6182	0.63158	0.77531	0.81461	1.2276	1.2898	1.5833	50
11	.61818	.78604	.78645	.2715	.2722	.6176	.63180	.77513	.81509	.2268	.2901	.5828	49
12	.61841	.78586	.78692	.2708	.2725	.6170	.63203	.77494	.81558	.2261	.2904	.5822	48
13	.61864	.78568	.78739	.2700	.2728	.6164	.63225	.77476	.81606	.2254	.2907	.5816	47
14	.61886	.78550	.78786	.2692	.2731	.6159	.63248	.77458	.81655	.2247	.2910	.5811	46
15	0.61909	0.78532	0.78834	1.2685	1.2734	1.6153	0.63270	0.77439	0.81703	1.2239	1.2913	1.5805	45
16	.61932	.78514	.78881	.2677	.2737	.6147	.63293	.77421	.81752	.2232	.2916	.5799	44
17	.61955	.78496	.78928	.2670	.2739	.6141	.63315	.77402	.81800	.2225	.2919	.5794	43
18	.61978	.78478	.78975	.2662	.2742	.6135	.63338	.77384	.81849	.2218	.2922	.5788	42
19	.62001	.78460	.79022	.2655	.2745	.6129	.63360	.77365	.81898	.2210	.2926	.5783	41
20	0.62023	0.78441	0.79070	1.2647	1.2748	1.6123	0.63383	0.77347	0.81946	1.2203	1.2929	1.5777	40
21	.62046	.78423	.79117	.2639	.2751	.6117	.63405	.77329	.81995	.2196	.2932	.5771	39
22	.62069	.78405	.79164	.2632	.2754	.6111	.63428	.77310	.82043	.2189	.2935	.5766	38
23	.62092	.78387	.79212	.2624	.2757	.6105	.63450	.77292	.82092	.2181	.2938	.5760	37
24	.62115	.78369	.79259	.2617	.2760	.6099	.63473	.77273	.82141	.2174	.2941	.5755	36
25	0.62137	0.78351	0.79306	1.2609	1.2763	1.6093	0.63495	0.77255	0.82190	1.2167	1.2944	1.5749	35
26	.62160	.78333	.79354	.2602	.2766	.6087	.63518	.77236	.82238	.2160	.2947	.5743	34
27	.62183	.78315	.79401	.2594	.2769	.6081	.63540	.77218	.82287	.2152	.2950	.5738	33
28	.62206	.78297	.79449	.2587	.2772	.6077	.63563	.77199	.82336	.2145	.2953	.5732	32
29	.62229	.78279	.79496	.2579	.2775	.6070	.63585	.77181	.82385	.2138	.2956	.5727	31
30	0.62251	0.78261	0.79543	1.2572	1.2778	1.6064	0.63608	0.77162	0.82434	1.2131	1.2960	1.5721	30
31	.62274	.78243	.79591	.2564	.2781	.6058	.63630	.77144	.82482	.2124	.2963	.5716	29
32	.62297	.78224	.79639	.2557	.2784	.6052	.63653	.77125	.82531	.2117	.2966	.5710	28
33	.62320	.78206	.79686	.2549	.2787	.6046	.63675	.77107	.82580	.2109	.2969	.5705	27
34	.62342	.78188	.79734	.2542	.2790	.6040	.63697	.77088	.82629	.2102	.2972	.5699	26
35	0.62365	0.78170	0.79781	1.2534	1.2793	1.6034	0.63720	0.77070	0.82678	1.2095	1.2975	1.5694	25
36	.62388	.78152	.79829	.2527	.2795	.6029	.63742	.77051	.82727	.2088	.2978	.5688	24
37	.62411	.78134	.79876	.2519	.2798	.6023	.63765	.77033	.82776	.2081	.2981	.5683	23
38	.62433	.78116	.79924	.2512	.2801	.6017	.63787	.77014	.82825	.2074	.2985	.5677	22
39	.62456	.78097	.79972	.2504	.2804	.6011	.63810	.76996	.82874	.2066	.2988	.5672	21
40	0.62479	0.78079	0.80020	1.2497	1.2807	1.6005	0.63832	0.76977	0.82923	1.2059	1.2991	1.5666	20
41	.62501	.78061	.80067	.2489	.2810	.6000	.63854	.76958	.82972	.2052	.2994	.5661	19
42	.62524	.78043	.80115	.2482	.2813	.5994	.63877	.76940	.83022	.2045	.2997	.5655	18
43	.62547	.78025	.80163	.2475	.2816	.5988	.63899	.76921	.83071	.2038	.3000	.5650	17
44	.62570	.78007	.80211	.2467	.2819	.5982	.63921	.76903	.83120	.2031	.3003	.5644	16
45	0.62592	0.77988	0.80258	1.2460	1.2822	1.5976	0.63944	0.76884	0.83169	1.2024	1.3006	1.5639	15
46	.62615	.77970	.80306	.2452	.2825	.5971	.63966	.76865	.83218	.2016	.3010	.5633	14
47	.62638	.77952	.80354	.2445	.2828	.5965	.63989	.76847	.83267	.2009	.3013	.5628	13
48	.62660	.77934	.80402	.2437	.2831	.5959	.64011	.76828	.83317	.2002	.3016	.5622	12
49	.62683	.77915	.80450	.2430	.2834	.5953	.64033	.76810	.83366	.1995	.3019	.5617	11
50	0.62706	0.77897	0.80498	1.2423	1.2837	1.5947	0.64056	0.76791	0.83415	1.1988	1.3022	1.5611	10
51	.62728	.77879	.80546	.2415	.2840	.5942	.64078	.76772	.83465	.1981	.3025	.5606	9
52	.62751	.77861	.80594	.2408	.2843	.5936	.64100	.76754	.83514	.1974	.3029	.5600	8
53	.62774	.77842	.80642	.2400	.2846	.5930	.64123	.76735	.83563	.1967	.3032	.5595	7
54	.62796	.77824	.80690	.2393	.2849	.5924	.64145	.76716	.83613	.1960	.3035	.5590	6
55	0.62819	0.77806	0.80738	1.2386	1.2852	1.5919	0.64167	0.76698	0.83662	1.1953	1.3038	1.5584	5
56	.62841	.77788	.80786	.2378	.2855	.5913	.64189	.76679	.83712	.1946	.3041	.5579	4
57	.62864	.77769	.80834	.2371	.2858	.5907	.64212	.76660	.83761	.1939	.3044	.5573	3
58	.62887	.77751	.80882	.2364	.2861	.5901	.64234	.76642	.83811	.1932	.3048	.5568	2
59	.62909	.77733	.80930	.2356	.2864	.5896	.64256	.76623	.83860	.1924	.3051	.5563	1
60	0.62932	0.77715	0.80978	1.2349	1.2867	1.5890	0.64279	0.76604	0.83910	1.1917	1.3054	1.5557	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
128°						51°	129°						50°

NATURAL TRIGONOMETRIC FUNCTIONS

40°						139°	41°					138°	
M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.64279	0.76604	0.83910	1.1917	1.3054	1.5557	0.65606	0.75471	0.86929	1.1504	1.3250	1.5242	60
1	.64301	.76586	.83959	.1910	.3057	.5552	.65628	.75452	.86980	.1497	.3253	.5237	59
2	.64323	.76567	.84009	.1903	.3060	.5546	.65650	.75433	.87031	.1490	.3257	.5232	58
3	.64345	.76548	.84059	.1896	.3064	.5541	.65672	.75414	.87082	.1483	.3260	.5227	57
4	.64368	.76530	.84108	.1889	.3067	.5536	.65694	.75394	.87133	.1477	.3263	.5222	56
5	0.64390	0.76511	0.84158	1.1882	1.3070	1.5530	0.65716	0.75375	0.87184	1.1470	1.3267	1.5217	55
6	.64412	.76492	.84208	.1875	.3073	.5525	.65737	.75356	.87235	.1463	.3270	.5212	54
7	.64435	.76473	.84257	.1868	.3076	.5520	.65759	.75337	.87287	.1456	.3274	.5207	53
8	.64457	.76455	.84307	.1861	.3080	.5514	.65781	.75318	.87338	.1450	.3277	.5202	52
9	.64479	.76436	.84357	.1854	.3083	.5509	.65803	.75299	.87389	.1443	.3280	.5197	51
10	0.64501	0.76417	0.84407	1.1847	1.3086	1.5503	0.65825	0.75280	0.87441	1.1436	1.3284	1.5192	50
11	.64523	.76398	.84457	.1840	.3089	.5498	.65847	.75261	.87492	.1430	.3287	.5187	49
12	.64546	.76380	.84506	.1833	.3092	.5493	.65869	.75241	.87543	.1423	.3290	.5182	48
13	.64568	.76361	.84556	.1826	.3096	.5487	.65891	.75222	.87595	.1416	.3294	.5177	47
14	.64590	.76342	.84606	.1819	.3099	.5482	.65913	.75203	.87646	.1409	.3297	.5171	46
15	0.64612	0.76323	0.84656	1.1812	1.3102	1.5477	0.65934	0.75184	0.87698	1.1403	1.3301	1.5166	45
16	.64635	.76304	.84706	.1805	.3105	.5471	.65956	.75165	.87749	.1396	.3304	.5161	44
17	.64657	.76286	.84756	.1798	.3109	.5466	.65978	.75146	.87801	.1389	.3307	.5156	43
18	.64679	.76267	.84806	.1791	.3112	.5461	.66000	.75126	.87852	.1383	.3311	.5151	42
19	.64701	.76248	.84856	.1785	.3115	.5456	.66022	.75107	.87904	.1376	.3314	.5146	41
20	0.64723	0.76229	0.84906	1.1778	1.3118	1.5450	0.66044	0.75088	0.87955	1.1369	1.3318	1.5141	40
21	.64745	.76210	.84956	.1771	.3121	.5445	.66066	.75069	.88007	.1363	.3321	.5136	39
22	.64768	.76191	.85006	.1764	.3125	.5440	.66087	.75049	.88058	.1356	.3324	.5131	38
23	.64790	.76173	.85056	.1757	.3128	.5434	.66109	.75030	.88110	.1349	.3328	.5126	37
24	.64812	.76154	.85107	.1750	.3131	.5429	.66131	.75011	.88162	.1343	.3331	.5121	36
25	0.64834	0.76135	0.85157	1.1743	1.3134	1.5424	0.66153	0.74992	0.88213	1.1336	1.3335	1.5116	35
26	.64856	.76116	.85207	.1736	.3138	.5419	.66175	.74973	.88265	.1329	.3338	.5111	34
27	.64878	.76097	.85257	.1729	.3141	.5413	.66197	.74953	.88317	.1323	.3342	.5106	33
28	.64900	.76078	.85307	.1722	.3144	.5408	.66218	.74934	.88369	.1316	.3345	.5101	32
29	.64923	.76059	.85358	.1715	.3148	.5403	.66240	.74915	.88421	.1309	.3348	.5096	31
30	0.64945	0.76041	0.85408	1.1708	1.3151	1.5398	0.66262	0.74895	0.88472	1.1303	1.3352	1.5092	30
31	.64967	.76022	.85458	.1702	.3154	.5392	.66284	.74876	.88524	.1296	.3355	.5087	29
32	.64989	.76003	.85509	.1695	.3157	.5387	.66305	.74857	.88576	.1290	.3359	.5082	28
33	.65011	.75984	.85559	.1688	.3161	.5382	.66327	.74838	.88628	.1283	.3362	.5077	27
34	.65033	.75965	.85609	.1681	.3164	.5377	.66349	.74818	.88680	.1276	.3366	.5072	26
35	0.65055	0.75946	0.85660	1.1674	1.3167	1.5371	0.66371	0.74799	0.88732	1.1270	1.3369	1.5067	25
36	.65077	.75927	.85710	.1667	.3170	.5366	.66393	.74780	.88784	.1263	.3372	.5062	24
37	.65100	.75908	.85761	.1660	.3174	.5361	.66414	.74760	.88836	.1257	.3376	.5057	23
38	.65121	.75889	.85811	.1653	.3177	.5356	.66436	.74741	.88888	.1250	.3379	.5052	22
39	.65144	.75870	.85862	.1647	.3180	.5351	.66458	.74722	.88940	.1243	.3383	.5047	21
40	0.65166	0.75851	0.85912	1.1640	1.3184	1.5345	0.66479	0.74702	0.88992	1.1237	1.3386	1.5042	20
41	.65188	.75832	.85963	.1633	.3187	.5340	.66501	.74683	.89044	.1230	.3390	.5037	19
42	.65210	.75813	.86013	.1626	.3190	.5335	.66523	.74664	.89097	.1224	.3393	.5032	18
43	.65232	.75794	.86064	.1619	.3193	.5330	.66545	.74644	.89149	.1217	.3397	.5027	17
44	.65254	.75775	.86115	.1612	.3197	.5325	.66566	.74625	.89201	.1211	.3400	.5022	16
45	0.65276	0.75756	0.86165	1.1605	1.3200	1.5319	0.66588	0.74606	0.89253	1.1204	1.3404	1.5018	15
46	.65298	.75737	.86216	.1599	.3203	.5314	.66610	.74586	.89306	.1197	.3407	.5013	14
47	.65320	.75718	.86267	.1592	.3207	.5309	.66631	.74567	.89358	.1191	.3411	.5008	13
48	.65342	.75700	.86318	.1585	.3210	.5304	.66653	.74548	.89410	.1184	.3414	.5003	12
49	.65364	.75680	.86368	.1578	.3213	.5299	.66675	.74528	.89463	.1178	.3418	.4998	11
50	0.65386	0.75661	0.86419	1.1571	1.3217	1.5294	0.66697	0.74509	0.89515	1.1171	1.3421	1.4993	10
51	.65408	.75642	.86470	.1565	.3220	.5289	.66718	.74489	.89567	.1165	.3425	.4988	9
52	.65430	.75623	.86521	.1558	.3223	.5283	.66740	.74470	.89620	.1158	.3428	.4983	8
53	.65452	.75604	.86572	.1551	.3227	.5278	.66762	.74450	.89672	.1152	.3432	.4979	7
54	.65474	.75585	.86623	.1544	.3230	.5273	.66783	.74431	.89725	.1145	.3435	.4974	6
55	0.65496	0.75566	0.86674	1.1537	1.3233	1.5268	0.66805	0.74412	0.89777	1.1139	1.3439	1.4969	5
56	.65518	.75547	.86725	.1531	.3237	.5263	.66826	.74392	.89830	.1132	.3442	.4964	4
57	.65540	.75528	.86775	.1524	.3240	.5258	.66848	.74373	.89882	.1126	.3446	.4959	3
58	.65562	.75509	.86826	.1517	.3243	.5253	.66870	.74353	.89935	.1119	.3449	.4954	2
59	.65584	.75490	.86878	.1510	.3247	.5248	.66891	.74334	.89988	.1113	.3453	.4949	1
60	0.65606	0.75471	0.86929	1.1504	1.3250	1.5242	0.66913	0.74314	0.90040	1.1106	1.3456	1.4945	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M
130°						49°	131°					48°	

NATURAL TRIGONOMETRIC FUNCTIONS

42° 137° 43° 136°

M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	M
0	0.66913	0.74314	0.90040	1.1106	1.3456	1.4945	0.68200	0.73135	0.93251	1.0724	1.3673	1.4663	60
1	.66935	.74295	.90093	.1100	.3460	.4940	.68221	.73115	.93306	.0717	.3677	.4658	59
2	.66956	.74276	.90146	.1093	.3463	.4935	.68242	.73096	.93360	.0711	.3681	.4654	58
3	.66978	.74256	.90198	.1086	.3467	.4930	.68264	.73076	.93415	.0705	.3684	.4649	57
4	.66999	.74236	.90251	.1080	.3470	.4925	.68285	.73056	.93469	.0699	.3688	.4644	56
5	0.67021	0.74217	0.90304	1.1074	1.3474	1.4921	0.68306	0.73036	0.93524	1.0692	1.3692	1.4640	55
6	.67043	.74197	.90357	.1067	.3477	.4916	.68327	.73016	.93578	.0686	.3695	.4635	54
7	.67064	.74178	.90410	.1061	.3481	.4911	.68349	.72996	.93633	.0680	.3699	.4631	53
8	.67086	.74158	.90463	.1054	.3485	.4906	.68370	.72976	.93687	.0674	.3703	.4626	52
9	.67107	.74139	.90515	.1048	.3488	.4901	.68391	.72956	.93742	.0667	.3707	.4622	51
10	0.67129	0.74119	0.90568	1.1041	1.3492	1.4897	0.68412	0.72937	0.93797	1.0661	1.3710	1.4617	50
11	.67150	.74100	.90621	.1035	.3495	.4892	.68433	.72917	.93851	.0655	.3714	.4613	49
12	.67172	.74080	.90674	.1028	.3499	.4887	.68455	.72897	.93906	.0649	.3718	.4608	48
13	.67194	.74061	.90727	.1022	.3502	.4882	.68476	.72877	.93961	.0643	.3722	.4604	47
14	.67215	.74041	.90780	.1015	.3506	.4877	.68497	.72857	.94016	.0636	.3725	.4599	46
15	0.67237	0.74022	0.90834	1.1009	1.3509	1.4873	0.68518	0.72837	0.94071	1.0630	1.3729	1.4595	45
16	.67258	.74002	.90887	.1003	.3513	.4868	.68539	.72817	.94125	.0624	.3733	.4590	44
17	.67280	.73983	.90940	.0996	.3517	.4863	.68561	.72797	.94180	.0618	.3737	.4586	43
18	.67301	.73963	.90993	.0990	.3520	.4858	.68582	.72777	.94235	.0612	.3740	.4581	42
19	.67323	.73943	.91046	.0983	.3524	.4854	.68603	.72757	.94290	.0605	.3744	.4577	41
20	0.67344	0.73924	0.91099	1.0977	1.3527	1.4849	0.68624	0.72737	0.94345	1.0599	1.3748	1.4572	40
21	.67366	.73904	.91153	.0971	.3531	.4844	.68645	.72717	.94400	.0593	.3752	.4568	39
22	.67387	.73885	.91206	.0964	.3534	.4839	.68666	.72697	.94455	.0587	.3756	.4563	38
23	.67409	.73865	.91259	.0958	.3538	.4835	.68688	.72677	.94510	.0581	.3759	.4559	37
24	.67430	.73845	.91312	.0951	.3542	.4830	.68709	.72657	.94565	.0575	.3763	.4554	36
25	0.67452	0.73826	0.91366	1.0945	1.3545	1.4825	0.68730	0.72637	0.94620	1.0568	1.3767	1.4550	35
26	.67473	.73806	.91419	.0939	.3549	.4821	.68751	.72617	.94675	.0562	.3771	.4545	34
27	.67495	.73787	.91473	.0932	.3552	.4816	.68772	.72597	.94731	.0556	.3774	.4541	33
28	.67516	.73767	.91526	.0926	.3556	.4811	.68793	.72577	.94786	.0550	.3778	.4536	32
29	.67537	.73747	.91580	.0919	.3560	.4806	.68814	.72557	.94841	.0544	.3782	.4532	31
30	0.67559	0.73728	0.91633	1.0913	1.3563	1.4802	0.68835	0.72537	0.94896	1.0538	1.3786	1.4527	30
31	.67580	.73708	.91687	.0907	.3567	.4797	.68856	.72517	.94952	.0532	.3790	.4523	29
32	.67602	.73688	.91740	.0900	.3571	.4792	.68878	.72497	.95007	.0525	.3794	.4518	28
33	.67623	.73669	.91794	.0894	.3574	.4788	.68899	.72477	.95062	.0519	.3797	.4514	27
34	.67645	.73649	.91847	.0888	.3578	.4783	.68920	.72457	.95118	.0513	.3801	.4510	26
35	0.67666	0.73629	0.91901	1.0881	1.3581	1.4778	0.68941	0.72437	0.95173	1.0507	1.3805	1.4505	25
36	.67688	.73610	.91955	.0875	.3585	.4774	.68962	.72417	.95229	.0501	.3809	.4501	24
37	.67709	.73590	.92008	.0868	.3589	.4769	.68983	.72397	.95284	.0495	.3813	.4496	23
38	.67730	.73570	.92062	.0862	.3592	.4764	.69004	.72377	.95340	.0489	.3816	.4492	22
39	.67752	.73551	.92116	.0856	.3596	.4760	.69025	.72357	.95395	.0483	.3820	.4487	21
40	0.67773	0.73531	0.92170	1.0849	1.3600	1.4755	0.69046	0.72337	0.95451	1.0476	1.3824	1.4483	20
41	.67794	.73511	.92223	.0843	.3603	.4750	.69067	.72317	.95506	.0470	.3828	.4479	19
42	.67816	.73491	.92277	.0837	.3607	.4746	.69088	.72297	.95562	.0464	.3832	.4474	18
43	.67837	.73472	.92331	.0830	.3611	.4741	.69109	.72277	.95618	.0458	.3836	.4470	17
44	.67859	.73452	.92385	.0824	.3614	.4736	.69130	.72256	.95673	.0452	.3839	.4465	16
45	0.67880	0.73432	0.92439	1.0818	1.3618	1.4732	0.69151	0.72236	0.95729	1.0446	1.3843	1.4461	15
46	.67901	.73412	.92493	.0812	.3622	.4727	.69172	.72216	.95785	.0440	.3847	.4457	14
47	.67923	.73393	.92547	.0805	.3625	.4723	.69193	.72196	.95841	.0434	.3851	.4452	13
48	.67944	.73373	.92601	.0799	.3629	.4718	.69214	.72176	.95896	.0428	.3855	.4448	12
49	.67965	.73353	.92655	.0793	.3633	.4713	.69235	.72156	.95952	.0422	.3859	.4443	11
50	0.67987	0.73333	0.92709	1.0786	1.3636	1.4709	0.69256	0.72136	0.96008	1.0416	1.3863	1.4439	10
51	.68008	.73314	.92763	.0780	.3640	.4704	.69277	.72115	.96064	.0410	.3867	.4435	9
52	.68029	.73294	.92817	.0774	.3644	.4699	.69298	.72095	.96120	.0404	.3870	.4430	8
53	.68051	.73274	.92871	.0767	.3647	.4695	.69319	.72075	.96176	.0397	.3874	.4426	7
54	.68072	.73254	.92926	.0761	.3651	.4690	.69340	.72055	.96232	.0391	.3878	.4422	6
55	0.68093	0.73234	0.92980	1.0755	1.3655	1.4686	0.69361	0.72035	0.96288	1.0385	1.3882	1.4417	5
56	.68115	.73215	.93034	.0749	.3658	.4681	.69382	.72015	.96344	.0379	.3886	.4413	4
57	.68136	.73195	.93088	.0742	.3662	.4676	.69403	.71994	.96400	.0373	.3890	.4408	3
58	.68157	.73175	.93143	.0736	.3666	.4672	.69424	.71974	.96456	.0367	.3894	.4404	2
59	.68178	.73155	.93197	.0730	.3669	.4667	.69445	.71954	.96513	.0361	.3898	.4400	1
60	0.68200	0.73135	0.93251	1.0724	1.3673	1.4663	0.69466	0.71934	0.96569	1.0355	1.3902	1.4395	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	M

132° 47° 133° 46°

NATURAL TRIGONOMETRIC FUNCTIONS

44° **135°**

M	Sine	Cosine	Tangent	Cotangent	Secant	Cosecant	M
0	0.69466	0.71934	0.96569	1.0355	1.3902	1.4395	60
1	.69487	.71914	.96625	.0349	.3905	.4391	59
2	.69508	.71893	.96681	.0343	.3909	.4387	58
3	.69528	.71873	.96738	.0337	.3913	.4382	57
4	.69549	.71853	.96794	.0331	.3917	.4378	56
5	0.69570	0.71833	0.96850	1.0325	1.3921	1.4374	55
6	.69591	.71813	.96907	.0319	.3925	.4370	54
7	.69612	.71792	.96963	.0313	.3929	.4365	53
8	.69633	.71772	.97020	.0307	.3933	.4361	52
9	.69654	.71752	.97076	.0301	.3937	.4357	51
10	0.69675	0.71732	0.97133	1.0295	1.3941	1.4352	50
11	.69696	.71711	.97189	.0289	.3945	.4348	49
12	.69716	.71691	.97246	.0283	.3949	.4344	48
13	.69737	.71671	.97302	.0277	.3953	.4339	47
14	.69758	.71650	.97359	.0271	.3957	.4335	46
15	0.69779	0.71630	0.97416	1.0265	1.3960	1.4331	45
16	.69800	.71610	.97472	.0259	.3964	.4327	44
17	.69821	.71589	.97529	.0253	.3968	.4322	43
18	.69841	.71569	.97586	.0247	.3972	.4318	42
19	.69862	.71549	.97643	.0241	.3976	.4314	41
20	0.69883	0.71529	0.97700	1.0235	1.3980	1.4310	40
21	.69904	.71508	.97756	.0229	.3984	.4305	39
22	.69925	.71488	.97813	.0223	.3988	.4301	38
23	.69945	.71468	.97870	.0218	.3992	.4297	37
24	.69966	.71447	.97927	.0212	.3996	.4292	36
25	0.69987	0.71427	0.97984	1.0206	1.4000	1.4288	35
26	.70008	.71406	.98041	.0200	.4004	.4284	34
27	.70029	.71386	.98098	.0194	.4008	.4280	33
28	.70049	.71366	.98155	.0188	.4012	.4276	32
29	.70070	.71345	.98212	.0182	.4016	.4271	31
30	0.70091	0.71325	0.98270	1.0176	1.4020	1.4267	30
31	.70112	.71305	.98327	.0170	.4024	.4263	29
32	.70132	.71284	.98384	.0164	.4028	.4259	28
33	.70153	.71264	.98441	.0158	.4032	.4254	27
34	.70174	.71243	.98499	.0152	.4036	.4250	26
35	0.70194	0.71223	0.98556	1.0146	1.4040	1.4246	25
36	.70215	.71203	.98613	.0141	.4044	.4242	24
37	.70236	.71182	.98671	.0135	.4048	.4238	23
38	.70257	.71162	.98728	.0129	.4052	.4233	22
39	.70277	.71141	.98786	.0123	.4056	.4229	21
40	0.70298	0.71121	0.98843	1.0117	1.4060	1.4225	20
41	.70319	.71100	.98901	.0111	.4065	.4221	19
42	.70339	.71080	.98958	.0105	.4069	.4217	18
43	.70360	.71059	.99016	.0099	.4073	.4212	17
44	.70381	.71039	.99073	.0093	.4077	.4208	16
45	0.70401	0.71018	0.99131	1.0088	1.4081	1.4204	15
46	.70422	.70998	.99189	.0082	.4085	.4200	14
47	.70443	.70977	.99246	.0076	.4089	.4196	13
48	.70463	.70957	.99304	.0070	.4093	.4192	12
49	.70484	.70936	.99362	.0064	.4097	.4188	11
50	0.70505	0.70916	0.99420	1.0058	1.4101	1.4183	10
51	.70525	.70895	.99478	.0052	.4105	.4179	9
52	.70546	.70875	.99536	.0047	.4109	.4175	8
53	.70566	.70854	.99593	.0041	.4113	.4171	7
54	.70587	.70834	.99651	.0035	.4117	.4167	6
55	0.70608	0.70813	0.99709	1.0029	1.4122	1.4163	5
56	.70628	.70793	.99767	.0023	.4126	.4159	4
57	.70649	.70772	.99826	.0017	.4130	.4154	3
58	.70669	.70752	.99884	.0012	.4134	.4150	2
59	.70690	.70731	.99942	.0006	.4138	.4146	1
60	0.70711	0.70711	1.00000	1.0000	1.4142	1.4142	0
M	Cosine	Sine	Cotangent	Tangent	Cosecant	Secant	M

134° **45°**

LENGTH OF CIRCULAR ARCS FOR UNIT RADIUS

By the use of this table, the length of any arc may be found if the length of the radius and the angle of the segment are known.

Example:—Required the length of arc of segment of 32° 15′ 27″ with radius of 24 feet 3 inches.

From table: Length of arc (Radius 1) for 32° = .5585054
15′ = .0043633
27″ = .0001309
.5629996

.5629996 × 24.25 (length of radius) = 13.65274 feet.

DEGREES						MINUTES		SECONDS	
1°	.017 4533	61°	1.064 6508	121°	2.111 8484	1′	.000 2909	1″	.000 0048
2	.034 9066	62	1.082 1041	122	2.129 3017	2	.000 5818	2	.000 0097
3	.052 3599	63	1.099 5574	123	2.146 7550	3	.000 8727	3	.000 0145
4	.069 8132	64	1.117 0107	124	2.164 2083	4	.001 1636	4	.000 0194
5	.087 2665	65	1.134 4640	125	2.181 6616	5	.001 4544	5	.000 0242
6	.104 7198	66	1.151 9173	126	2.199 1149	6	.001 7453	6	.000 0291
7	.122 1730	67	1.169 3706	127	2.216 5682	7	.002 0362	7	.000 0339
8	.139 6263	68	1.186 8239	128	2.234 0214	8	.002 3271	8	.000 0388
9	.157 0796	69	1.204 2772	129	2.251 4747	9	.002 6180	9	.000 0436
10	.174 5329	70	1.221 7305	130	2.268 9280	10	.002 9089	10	.000 0485
11	.191 9862	71	1.239 1838	131	2.286 3813	11	.003 1998	11	.000 0533
12	.209 4395	72	1.256 6371	132	2.303 8346	12	.003 4907	12	.000 0582
13	.226 8928	73	1.274 0904	133	2.321 2879	13	.003 7815	13	.000 0630
14	.244 3461	74	1.291 5436	134	2.338 7412	14	.004 0724	14	.000 0679
15	.261 7994	75	1.308 9969	135	2.356 1945	15	.004 3633	15	.000 0727
16	.279 2527	76	1.326 4502	136	2.373 6478	16	.004 6542	16	.000 0776
17	.296 7060	77	1.343 9035	137	2.391 1011	17	.004 9451	17	.000 0824
18	.314 1593	78	1.361 3568	138	2.408 5544	18	.005 2360	18	.000 0873
19	.331 6126	79	1.378 8101	139	2.426 0077	19	.005 5269	19	.000 0921
20	.349 0659	80	1.396 2634	140	2.443 4610	20	.005 8178	20	.000 0970
21	.366 5191	81	1.413 7167	141	2.460 9142	21	.006 1087	21	.000 1018
22	.383 9724	82	1.431 1700	142	2.478 3675	22	.006 3995	22	.000 1067
23	.401 4257	83	1.448 6233	143	2.495 8208	23	.006 6904	23	.000 1115
24	.418 8790	84	1.466 0766	144	2.513 2741	24	.006 9813	24	.000 1164
25	.436 3323	85	1.483 5299	145	2.530 7274	25	.007 2722	25	.000 1212
26	.453 7856	86	1.500 9832	146	2.548 1807	26	.007 5631	26	.000 1261
27	.471 2389	87	1.518 4364	147	2.565 6340	27	.007 8540	27	.000 1309
28	.488 6922	88	1.535 8897	148	2.583 0873	28	.008 1449	28	.000 1357
29	.506 1455	89	1.553 3430	149	2.600 5406	29	.008 4358	29	.000 1406
30	.523 5988	90	1.570 7963	150	2.617 9939	30	.008 7266	30	.000 1454
31	.541 0521	91	1.588 2496	151	2.635 4472	31	.009 0175	31	.000 1503
32	.558 5054	92	1.605 7029	152	2.652 9005	32	.009 3084	32	.000 1551
33	.575 9587	93	1.623 1562	153	2.670 3538	33	.009 5993	33	.000 1600
34	.593 4119	94	1.640 6095	154	2.687 8070	34	.009 8902	34	.000 1648
35	.610 8652	95	1.658 0628	155	2.705 2603	35	.010 1811	35	.000 1697
36	.628 3185	96	1.675 5161	156	2.722 7136	36	.010 4720	36	.000 1745
37	.645 7718	97	1.692 9694	157	2.740 1669	37	.010 7629	37	.000 1794
38	.663 2251	98	1.710 4227	158	2.757 6202	38	.011 0538	38	.000 1842
39	.680 6784	99	1.727 8760	159	2.775 0735	39	.011 3446	39	.000 1891
40	.698 1317	100	1.745 3293	160	2.792 5268	40	.011 6355	40	.000 1939
41	.715 5850	101	1.762 7825	161	2.809 9801	41	.011 9264	41	.000 1988
42	.733 0383	102	1.780 2358	162	2.827 4334	42	.012 2173	42	.000 2036
43	.750 4916	103	1.797 6891	163	2.844 8867	43	.012 5082	43	.000 2085
44	.767 9449	104	1.815 1424	164	2.862 3400	44	.012 7991	44	.000 2133
45	.785 3982	105	1.832 5957	165	2.879 7933	45	.013 0900	45	.000 2182
46	.802 8515	106	1.850 0490	166	2.897 2466	46	.013 3809	46	.000 2230
47	.820 3047	107	1.867 5023	167	2.914 6999	47	.013 6717	47	.000 2279
48	.837 7580	108	1.884 9556	168	2.932 1531	48	.013 9626	48	.000 2327
49	.855 2113	109	1.902 4089	169	2.949 6064	49	.014 2535	49	.000 2376
50	.872 6646	110	1.919 8622	170	2.967 0597	50	.014 5444	50	.000 2424
51	.890 1179	111	1.937 3155	171	2.984 5130	51	.014 8353	51	.000 2473
52	.907 5712	112	1.954 7688	172	3.001 9663	52	.015 1262	52	.000 2521
53	.925 0245	113	1.972 2221	173	3.019 4196	53	.015 4171	53	.000 2570
54	.942 4778	114	1.989 6753	174	3.036 8729	54	.015 7080	54	.000 2618
55	.959 9311	115	2.007 1286	175	3.054 3262	55	.015 9989	55	.000 2666
56	.977 3844	116	2.024 5819	176	3.071 7795	56	.016 2897	56	.000 2715
57	.994 8377	117	2.042 0352	177	3.089 2328	57	.016 5806	57	.000 2763
58	1.012 2910	118	2.059 4885	178	3.106 6861	58	.016 8715	58	.000 2812
59	1.029 7443	119	2.076 9418	179	3.124 1394	59	.017 1624	59	.000 2860
60	1.047 1976	120	2.094 3951	180	3.141 5927	60	.017 4533	60	.000 2909

HARDNESS CONVERSION TABLE

Brinell (3000 Kg.)		Rockwell		Shore	Vickers	Tensile Strength
Diam.	Number	C	B			
2.20	780	68		100	1185	
2.25	745	67		97	1087	
2.30	712	66		94	990	
2.35	682	64		90	928	
2.40	653	63		87	867	
2.45	627	62		83	803	
2.50	601	60		80	746	295,900
2.55	578	58		77	694	284,300
2.60	555	56		74	649	273,300
2.65	534	55		72	606	262,900
2.70	514	53		69	587	253,100
2.75	495	52		67	551	243,800
2.80	477	50		65	534	235,000
2.85	461	48		62	502	226,600
2.90	444	46		59	474	218,700
2.95	429	44		56	460	211,200
3.00	415	42		54	435	204,100
3.05	401	41		52	423	197,300
3.10	388	39		50	401	190,800
3.15	375	38		49	390	184,600
3.20	363	37		47	380	178,800
3.25	352	36		46	361	173,200
3.30	341	35		45	344	167,800
3.35	331	34		44	335	162,700
3.40	321	33		43	320	157,800
3.45	311	32		42	312	152,100
3.50	302	31	106	41	305	148,600
3.55	293	30	105	40	291	144,300
3.60	285	29	104	39	285	140,200
3.65	277	28	103	38	278	136,200
3.70	269	27	102.5	37	272	132,400
3.75	262	26	102	36	261	128,800
3.80	255	25	101	35	255	125,300
3.85	248	24	100	34	250	121,900
3.90	241	23	99.5	33	240	118,700
3.95	235	22	99	32	235	115,500
4.00	229	21	98	31	226	112,000
4.05	223	20	97	30	221	109,700
4.10	217	19	96	29	217	106,900
4.15	212	18	95.5	28	213	104,200
4.20	207	17	94.5	27	209	101,600
4.25	201	16	93.5	26		99,100
4.30	197	15	93	25		96,700
4.35	192	14	92	24		94,400
4.40	187	12	91	23		92,200
4.45	183	11	90	22		90,000
4.50	179	10	88	21		87,900
4.55	174		87	20		85,800
4.60	170		86	19		83,900
4.65	167		85	19		82,000
4.70	163		84	18		80,100
4.75	159		83	18		78,300
4.80	156		82	18		76,600
4.85	152		81	17		74,900
4.90	149		80	17		73,300

HARDNESS CONVERSION TABLE

Brinell (3000 Kg.)		Rockwell		Shore	Vickers	Tensile Strength
Diam.	Number	C	B			
4.95	146		79	17		71,000
5.00	143		77	17		70,200
5.05	140		76	16		69,400
5.10	137		75	16		67,800
5.15	134		74	16		66,300
5.20	131		72	16		64,800
5.25	128		71	16		63,300
5.30	126		70	15		62,300
5.35	123		69	15		61,900
5.40	121		68	15		59,900
5.45	118		67			58,500
5.50	116		66			57,400
5.55	114		64			56,600
5.60	112		63			55,800
5.65	109		62			54,900
5.70	107		60			54,100
5.75	105		58			53,300
5.80	103		57			52,400
5.85	101		56			51,600
5.90	99		55			50,700
5.95	97		53			49,900
6.00	95		51			49,000
*	93		50			
	92		49			
	90		48			
	88		47			
	87		46			
	86		45			
	85		44			
	83		43			
	82		42			
	81		41			
	80		40			
	79		39			
	78		38			
	77		37			
	76		36			
	75		35			
	74		33			
	73		31			
	72		30			

The hardness values are from tests taken on machined tensile test bars cut from 1-inch round or larger stock in the as-rolled, annealed, normalized, or quenched and drawn conditions. They give direct relation between hardness and tensile strength and are not affected by surface decarburization, skin hardness, surface cold work and other factors which influence the values of hardness tests taken on the original bar surface.

The Shore or scleroscope values vary over a wider range as compared with the tensile strength, than do the other measures of hardness. This is due to the influence of the elastic limit in this determination.

*Use 500 or 1000 kg. load.

This table will be found to be approximately correct. It cannot cover all conditions since size, shape, mass and other variables affect the above properties and their relationship.

LOAD CONVERSION TABLE FOR TESTING

TONS PER SQUARE INCH TO POUNDS PER SQUARE INCH						KILOGRAMS PER SQUARE MILLIMETER TO POUNDS PER SQUARE INCH					
Tons per Sq. in.	Pounds per Sq. in.	Tons per Sq. in.	Pounds per Sq. in.	Tons per Sq. in.	Pounds per Sq. in.	Kg. per Sq. mm.	Pounds per Sq. in.	Kg. per Sq. mm.	Pounds per Sq. in.	Kg. per Sq. mm.	Pounds per Sq. in.
10.0	22,400	35.0	78,400	70	156,800	10	14,223	60	85,340	110	156,457
10.5	23,520	35.5	79,520	71	159,040	11	15,646	61	86,763	111	157,880
11.0	24,640	36.0	80,640	72	161,280	12	17,068	62	88,185	112	159,302
11.5	25,760	36.5	81,760	73	163,520	13	18,490	63	89,607	113	160,724
12.0	26,880	37.0	82,880	74	165,760	14	19,913	64	91,030	114	162,147
12.5	28,000	37.5	84,000	75	168,000	15	21,335	65	92,452	115	163,569
13.0	29,120	38.0	85,120	76	170,240	16	22,757	66	93,874	116	164,991
13.5	30,240	38.5	86,240	77	172,480	17	24,180	67	95,297	117	166,414
14.0	31,360	39.0	87,360	78	174,720	18	25,602	68	96,719	118	167,836
14.5	32,480	39.5	88,480	79	176,960	19	27,024	69	98,141	119	169,258
15.0	33,600	40.0	89,600	80	179,200	20	28,447	70	99,564	120	170,681
15.5	34,720	40.5	90,720	81	181,440	21	29,869	71	100,986	121	172,103
16.0	35,840	41.0	91,840	82	183,680	22	31,291	72	102,408	122	173,525
16.5	36,960	41.5	92,960	83	185,920	23	32,714	73	103,831	123	174,948
17.0	38,080	42.0	94,080	84	188,160	24	34,136	74	105,253	124	176,370
17.5	39,200	42.5	95,200	85	190,400	25	35,558	75	106,675	125	177,792
18.0	40,320	43.0	96,320	86	192,640	26	36,981	76	108,098	126	179,215
18.5	41,440	43.5	97,440	87	194,880	27	38,403	77	109,520	127	180,637
19.0	42,560	44.0	98,560	88	197,120	28	39,826	78	110,943	128	182,059
19.5	43,680	44.5	99,680	89	199,360	29	41,248	79	112,365	129	183,482
20.0	44,800	45.0	100,800	90	201,600	30	42,670	80	113,787	130	184,904
20.5	45,920	45.5	101,920	91	203,840	31	44,093	81	115,210	131	186,327
21.0	47,040	46.0	103,040	92	206,080	32	45,515	82	116,632	132	187,749
21.5	48,160	46.5	104,160	93	208,320	33	46,937	83	118,054	133	189,171
22.0	49,280	47.0	105,280	94	210,560	34	48,360	84	119,477	134	190,594
22.5	50,400	47.5	106,400	95	212,800	35	49,782	85	120,899	135	192,016
23.0	51,520	48.0	107,520	96	215,040	36	51,204	86	122,321	136	193,438
23.5	52,640	48.5	108,640	97	217,280	37	52,627	87	123,744	137	194,861
24.0	53,760	49.0	109,760	98	219,520	38	54,049	88	125,166	138	196,283
24.5	54,880	49.5	110,880	99	221,760	39	55,471	89	126,588	139	197,705
25.0	56,000	50	112,000	100	224,000	40	56,894	90	128,011	140	199,128
25.5	57,120	51	114,240	101	226,240	41	58,316	91	129,433	141	200,550
26.0	58,240	52	116,480	102	228,480	42	59,738	92	130,855	142	201,972
26.5	59,360	53	118,720	103	230,720	43	61,161	93	132,278	143	203,395
27.0	60,480	54	120,960	104	232,960	44	62,583	94	133,700	144	204,817
27.5	61,600	55	123,200	105	235,200	45	64,005	95	135,122	145	206,239
28.0	62,720	56	125,440	106	237,440	46	65,428	96	136,545	146	207,662
28.5	63,840	57	127,680	107	239,680	47	66,850	97	137,967	147	209,084
29.0	64,960	58	129,920	108	241,920	48	68,272	98	139,389	148	210,506
29.5	66,080	59	132,160	109	244,160	49	69,695	99	140,812	149	211,929
30.0	67,200	60	134,400	110	246,400	50	71,117	100	142,234	150	213,351
30.5	68,320	61	136,640	111	248,640	51	72,539	101	143,656	151	214,773
31.0	69,440	62	138,880	112	250,880	52	73,962	102	145,079	152	216,196
31.5	70,560	63	141,120	113	253,120	53	75,384	103	146,501	153	217,618
32.0	71,680	64	143,360	114	255,360	54	76,806	104	147,923	154	219,040
32.5	72,800	65	145,600	115	257,600	55	78,229	105	149,346	155	220,463
33.0	73,920	66	147,840	116	259,840	56	79,651	106	150,768	156	221,885
33.5	75,040	67	150,080	117	262,080	57	81,073	107	152,190	157	223,307
34.0	76,160	68	152,320	118	264,320	58	82,496	108	153,613	158	224,730
34.5	77,280	69	154,560	119	266,560	59	83,918	109	155,035	159	226,152

BRINELL HARDNESS NUMERALS

Diam.	Kg. 5000	Kg. 3000	Kg. 1000	Kg. 500	Diam.	Kg. 5000	Kg. 3000	Kg. 1000	Kg. 500
2.00	1575	945	315	158	4.50	298	179	59.5	29.8
2.05	1499	899	300	150	4.55	291	174	58.1	29.1
2.10	1427	856	285	143	4.60	284	170	56.8	28.4
2.15	1361	817	272	136	4.65	278	167	55.8	27.8
2.20	1299	780	260	130	4.70	271	163	54.3	27.1
2.25	1241	745	248	124	4.75	265	159	53.0	26.5
2.30	1187	712	237	119	4.80	259	156	51.9	25.9
2.35	1137	682	227	114	4.85	254	152	50.7	25.4
2.40	1089	653	218	109	4.90	248	149	49.6	24.8
2.45	1044	627	209	104	4.95	243	146	48.6	24.3
2.50	1002	601	200	100	5.00	238	143	47.5	23.8
2.55	963	578	193	96.3	5.05	233	140	46.5	23.3
2.60	926	555	185	92.6	5.10	228	137	45.5	22.8
2.65	890	534	178	89.0	5.15	223	134	44.6	22.3
2.70	857	514	171	85.7	5.20	218	131	43.7	21.8
2.75	826	495	165	82.6	5.25	214	128	42.8	21.4
2.80	796	477	159	79.6	5.30	209	126	41.9	20.9
2.85	768	461	154	76.8	5.35	205	123	41.0	20.5
2.90	741	444	148	74.1	5.40	201	121	40.2	20.1
2.95	715	429	143	71.5	5.45	197	118	39.4	19.7
3.00	691	415	138	69.1	5.50	193	116	38.6	19.3
3.05	668	401	134	66.8	5.55	189	114	37.9	18.9
3.10	646	388	129	64.6	5.60	186	111	37.1	18.6
3.15	625	375	125	62.5	5.65	182	109	36.4	18.2
3.20	605	363	121	60.5	5.70	178	107	35.7	17.8
3.25	586	352	117	58.6	5.75	175	105	35.0	17.5
3.30	568	341	114	56.8	5.80	172	103	34.3	17.2
3.35	551	331	110	55.1	5.85	168	101	33.7	16.8
3.40	534	321	107	53.4	5.90	165	99.2	33.1	16.5
3.45	518	311	104	51.8	5.95	162	97.3	32.4	16.2
3.50	503	302	101	50.3	6.00	159	95.5	31.8	15.9
3.55	489	293	97.7	48.9	6.05	156	93.7	31.2	15.6
3.60	475	285	94.9	47.5	6.10	153	92.0	30.7	15.3
3.65	461	277	92.3	46.1	6.15	151	90.3	30.1	15.1
3.70	449	269	89.7	44.9	6.20	148	88.7	29.6	14.8
3.75	436	262	87.2	43.6	6.25	145	87.1	29.0	14.5
3.80	424	255	84.9	42.4	6.30	142	85.5	28.5	14.2
3.85	413	248	82.6	41.3	6.35	140	84.0	28.0	14.0
3.90	402	241	80.4	40.2	6.40	137	82.5	27.5	13.7
3.95	391	235	78.3	39.1	6.45	135	81.0	27.0	13.5
4.00	381	229	76.3	38.1	6.50	133	79.6	26.5	13.3
4.05	371	223	74.3	37.1	6.55	130	78.2	26.1	13.0
4.10	362	217	72.4	36.2	6.60	128	76.8	25.6	12.8
4.15	353	212	70.6	35.3	6.65	126	75.4	25.1	12.6
4.20	344	207	68.8	34.4	6.70	124	74.1	24.7	12.4
4.25	336	201	67.1	33.6	6.75	121	72.8	24.3	12.1
4.30	328	197	65.5	32.8	6.80	119	71.6	23.9	11.9
4.35	320	192	63.9	32.0	6.85	117	70.4	23.5	11.7
4.40	312	187	62.4	31.2	6.90	115	69.1	23.0	11.5
4.45	305	183	60.9	30.5	6.95	113	68.0	22.7	11.3
					7.00	111	66.8	22.3	11.1

Note: For other pressures the hardness numbers are in proportion to those given in the table; e. g., for 200 kg. are 1/5 of those for 1000 kg., etc.

DECIMALS OF A FOOT FOR EACH 64TH OF AN INCH

Inch	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″
0	0	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167
1/64	.0013	.0846	.1680	.2513	.3346	.4180	.5013	.5846	.6680	.7513	.8346	.9180
1/32	.0026	.0859	.1693	.2526	.3359	.4193	.5026	.5859	.6693	.7526	.8359	.9193
3/64	.0039	.0872	.1706	.2539	.3372	.4206	.5039	.5872	.6706	.7539	.8372	.9206
1/16	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	.9219
5/64	.0065	.0898	.1732	.2565	.3398	.4232	.5065	.5898	.6732	.7565	.8398	.9232
3/32	.0078	.0911	.1745	.2578	.3411	.4245	.5078	.5911	.6745	.7578	.8411	.9245
7/64	.0091	.0924	.1758	.2591	.3424	.4258	.5091	.5924	.6758	.7591	.8424	.9258
1/8	.0104	.0937	.1771	.2604	.3437	.4271	.5104	.5937	.6771	.7604	.8437	.9271
9/64	.0117	.0951	.1784	.2617	.3451	.4284	.5117	.5951	.6784	.7617	.8451	.9284
5/32	.0130	.0964	.1797	.2630	.3464	.4297	.5130	.5964	.6797	.7630	.8464	.9297
11/64	.0143	.0977	.1810	.2643	.3477	.4310	.5143	.5977	.6810	.7643	.8477	.9310
3/16	.0156	.0990	.1823	.2656	.3490	.4323	.5156	.5990	.6823	.7656	.8490	.9323
13/64	.0169	.1003	.1836	.2669	.3503	.4336	.5169	.6003	.6836	.7669	.8503	.9336
7/32	.0182	.1016	.1849	.2682	.3516	.4349	.5182	.6016	.6849	.7682	.8516	.9349
15/64	.0195	.1029	.1862	.2695	.3529	.4362	.5195	.6029	.6862	.7695	.8529	.9362
1/4	.0208	.1042	.1875	.2708	.3542	.4375	.5208	.6042	.6875	.7708	.8542	.9375
17/64	.0221	.1055	.1888	.2721	.3555	.4388	.5221	.6055	.6888	.7721	.8555	.9388
9/32	.0234	.1068	.1901	.2734	.3568	.4401	.5234	.6068	.6901	.7734	.8568	.9401
19/64	.0247	.1081	.1914	.2747	.3581	.4414	.5247	.6081	.6914	.7747	.8581	.9414
5/16	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6094	.6927	.7760	.8594	.9427
21/64	.0273	.1107	.1940	.2773	.3607	.4440	.5273	.6107	.6940	.7773	.8607	.9440
11/32	.0286	.1120	.1953	.2786	.3620	.4453	.5286	.6120	.6953	.7786	.8620	.9453
23/64	.0299	.1133	.1966	.2799	.3633	.4466	.5299	.6133	.6966	.7799	.8633	.9466
3/8	.0312	.1146	.1979	.2812	.3646	.4479	.5312	.6146	.6979	.7812	.8646	.9479
25/64	.0326	.1159	.1992	.2826	.3659	.4492	.5326	.6159	.6992	.7826	.8659	.9492
13/32	.0339	.1172	.2005	.2839	.3672	.4505	.5339	.6172	.7005	.7839	.8672	.9505
27/64	.0352	.1185	.2018	.2852	.3685	.4518	.5352	.6185	.7018	.7852	.8685	.9518
7/16	.0365	.1198	.2031	.2865	.3698	.4531	.5365	.6198	.7031	.7865	.8698	.9531
29/64	.0378	.1211	.2044	.2878	.3711	.4544	.5378	.6211	.7044	.7878	.8711	.9544
15/32	.0391	.1224	.2057	.2891	.3724	.4557	.5391	.6224	.7057	.7891	.8724	.9557
31/64	.0404	.1237	.2070	.2904	.3737	.4570	.5404	.6237	.7070	.7904	.8737	.9570
1/2	.0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	.9583

DECIMALS OF A FOOT FOR EACH 64TH OF AN INCH

(CONTINUED)

Inch	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″
33/64	.0430	.1263	.2096	.2930	.3763	.4596	.5430	.6263	.7096	.7930	.8763	.9596
17/32	.0443	.1276	.2109	.2943	.3776	.4609	.5443	.6276	.7109	.7943	.8776	.9609
35/64	.0456	.1289	.2122	.2956	.3789	.4622	.5456	.6289	.7122	.7956	.8789	.9622
9/16	.0469	.1302	.2135	.2969	.3802	.4635	.5469	.6302	.7135	.7969	.8802	.9635
37/64	.0482	.1315	.2148	.2982	.3815	.4648	.5482	.6315	.7148	.7982	.8815	.9648
19/32	.0495	.1328	.2161	.2995	.3828	.4661	.5495	.6328	.7161	.7995	.8828	.9661
39/64	.0508	.1341	.2174	.3008	.3841	.4674	.5508	.6341	.7174	.8008	.8841	.9674
5/8	.0521	.1354	.2188	.3021	.3854	.4688	.5521	.6354	.7188	.8021	.8854	.9688
41/64	.0534	.1367	.2201	.3034	.3867	.4701	.5534	.6367	.7201	.8034	.8867	.9701
21/32	.0547	.1380	.2214	.3047	.3880	.4714	.5547	.6380	.7214	.8047	.8880	.9714
43/64	.0560	.1393	.2227	.3060	.3893	.4727	.5560	.6393	.7227	.8060	.8893	.9727
11/16	.0573	.1406	.2240	.3073	.3906	.4740	.5573	.6406	.7240	.8073	.8906	.9740
45/64	.0586	.1419	.2253	.3086	.3919	.4753	.5586	.6419	.7253	.8086	.8919	.9753
23/32	.0599	.1432	.2266	.3099	.3932	.4766	.5599	.6432	.7266	.8099	.8932	.9766
47/64	.0612	.1445	.2279	.3112	.3945	.4779	.5612	.6445	.7279	.8112	.8945	.9779
3/4	.0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792
49/64	.0638	.1471	.2305	.3138	.3971	.4805	.5638	.6471	.7305	.8138	.8971	.9805
25/32	.0651	.1484	.2318	.3151	.3984	.4818	.5651	.6484	.7318	.8151	.8984	.9818
51/64	.0664	.1497	.2331	.3164	.3997	.4831	.5664	.6497	.7331	.8164	.8997	.9831
13/16	.0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844
53/64	.0690	.1523	.2357	.3190	.4023	.4857	.5690	.6523	.7357	.8190	.9023	.9857
27/32	.0703	.1536	.2370	.3203	.4036	.4870	.5703	.6536	.7370	.8203	.9036	.9870
55/64	.0716	.1549	.2383	.3216	.4049	.4883	.5716	.6549	.7383	.8216	.9049	.9883
7/8	.0729	.1562	.2396	.3229	.4062	.4896	.5729	.6562	.7396	.8229	.9062	.9896
57/64	.0742	.1576	.2409	.3242	.4076	.4909	.5742	.6576	.7409	.8242	.9076	.9909
29/32	.0755	.1589	.2422	.3255	.4089	.4922	.5755	.6589	.7422	.8255	.9089	.9922
59/64	.0768	.1602	.2435	.3268	.4102	.4935	.5768	.6602	.7435	.8268	.9102	.9935
15/16	.0781	.1615	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9948
61/64	.0794	.1628	.2461	.3294	.4128	.4961	.5794	.6628	.7461	.8294	.9128	.9961
31/32	.0807	.1641	.2474	.3307	.4141	.4974	.5807	.6641	.7474	.8307	.9141	.9974
63/64	.0820	.1654	.2487	.3320	.4154	.4987	.5820	.6654	.7487	.8320	.9154	.9987
1												1.0000

DECIMALS OF AN INCH FOR EACH 64TH

WITH MILLIMETER EQUIVALENTS AND B.W.G. COMPARISON TABLE

Fraction	Decimal	Millimeters	Fraction	Decimal	Millimeters
1/64	.015625	0.39688	33/64	.515625	13.09690
1/32	.03125	0.79375	17/32	.53125	13.49378
3/64	.046875	1.19063	35/64	.546875	13.89065
1/16	.0625	1.58750	9/16	.5625	14.28753
5/64	.078125	1.98438	37/64	.578125	14.68440
3/32	.09375	2.38125	19/32	.59375	15.08128
7/64	.109375	2.77813	39/64	.609375	15.47816
1/8	.125	3.17501	5/8	.625	15.87503
9/64	.140625	3.57188	41/64	.640625	16.27191
5/32	.15625	3.96876	21/32	.65625	16.66878
11/64	.171875	4.36563	43/64	.671875	17.06566
3/16	.1875	4.76251	11/16	.6875	17.46253
13/64	.203125	5.15939	45/64	.703125	17.85941
7/32	.21875	5.55626	23/32	.71875	18.25629
15/64	.234375	5.95314	47/64	.734375	18.65316
1/4	.25	6.35001	3/4	.75	19.05004
17/64	.265625	6.74689	49/64	.765625	19.44691
9/32	.28125	7.14376	25/32	.78125	19.84379
19/64	.296875	7.54064	51/64	.796875	20.24067
5/16	.3125	7.93752	13/16	.8125	20.63754
21/64	.328125	8.33439	53/64	.828125	21.03442
11/32	.34375	8.73127	27/32	.84375	21.43129
23/64	.359375	9.12814	55/64	.859375	21.82817
3/8	.375	9.52502	7/8	.875	22.22504
25/64	.390625	9.92189	57/64	.890625	22.62192
13/32	.40625	10.31877	29/32	.90625	23.01880
27/64	.421875	10.71565	59/64	.921875	23.41567
7/16	.4375	11.11252	15/16	.9375	23.81255
29/64	.453125	11.50940	61/64	.953125	24.20942
15/32	.46875	11.90627	31/32	.96875	24.60630
31/64	.484375	12.30315	63/64	.984375	25.00318
1/2	.5	12.70003	1	1.	25.40005

Birmingham Wire Gage			
No.	In.	No.	In.
36	.004	15	.072
35	.005	14	.083
34	.007	13	.095
33	.008	12	.109
32	.009	11	.120
31	.010	10	.134
30	.012	9	.148
29	.013	8	.165
28	.014	7	.180
27	.016	6	.203
26	.018	5	.220
25	.020	4	.238
24	.022	3	.259
23	.025	2	.284
22	.028	1	.300
21	.032	1-0	.340
20	.035	2-0s	.380
19	.042	3-0s	.425
18	.049	4-0s	.454
17	.058	5-0s	.500
16	.065		

SECTION NUMBER INDEX

SECTION NUMBER INDEX

SECTION NUMBER INDEX

SECTION NUMBER INDEX

PACIFIC COAST SECTIONS

SECTION NUMBER INDEX

GENERAL INDEX

A

B

D

E

H

I

K

L

M

Q

R

S

Y

Z

BETHLEHEM STEEL COMPANY

BETHLEHEM, PA.

PARTIAL LIST OF PRODUCTS

Alloy Steels—Open hearth and electric furnace steels for all purposes; bars, strip, billets and blooms; hot-rolled, cold-drawn, rough-turned or ground; normalized, annealed or heat treated; S. A. E. steels, Mayari nickel-chromium steels, Mayari engine bolt and staybolt steels, silico-manganese spring steel; Supertemp, for superior physical properties at high temperatures; Nitralloy.

Automobile Steel Shapes and Forms—For forgings and machined parts; wheel rim sections, springs, axles and brake drums.

Automobile Tire Molds and Rings.

Axles, Wrought Steel—For passenger and freight cars; engine, tender and trailer trucks; electric cars; mine locomotives and mine cars; cinder, ore and other industrial cars.

Bands—Pipe and tank bands.

Barges and Hulls—Steel.

Bars, Iron—Chain, staybolt and engine bolt iron and muck bar.

Bars, Carbon Steel—Black as rolled; annealed, heat treated; turned or ground; S. A. E. specification and special analyses. Bessemer and open hearth carbon steels; merchant bars in regular and special shapes.

Bars, Concrete Reinforcing—New billet and rail steel; plain and deformed bars of constant section, in standard rounds and squares. Bent and spirals.

Bins, Steel—Coal, coke, gravel, sand, etc.

Blanks—Rolled steel gear blanks; fly wheels, crane wheels, tire molds and mold rings, shaft couplings, brake wheels, brake drums and other circular forgings.

Blast Furnace and Steel Works Construction.

Blooms, Billets and Slabs—Re-rolling and forging quality.

Boiler Tubes—Genuine old-fashioned knobbled charcoal iron tubes, lap-welded. Double pass steel tubes, double pass copper-bearing steel tubes. Locomotive tubes.

Bolts—All kinds; plain and galvanized; heat-treated, carbon and alloy steels; machine, carriage, lag and special types; Mayari steel frog, track and fitting-up bolts; staybolts, hollow and solid. Dardelet self-locking threaded bolts. Bolt ends. Clevises. Turnbuckles. Sleeves.

Bridges, Steel—Bascule, cantilever, catenary, girder, lift, signal, suspension, truss and other bridges. Steel frame trestles, viaducts, coal and ore handling bridges and towers.

Buildings—Machine shops, foundries, power houses, mill and industrial buildings; office, hotel and apartment buildings; railway passenger and freight depots and terminals, train-sheds; public buildings; grandstands; freight, recreation and tubular piers; warehouses.

PARTIAL LIST OF PRODUCTS—Continued

BUILDING MATERIALS, STEEL—Expanded and sheet metal lath; base and corner beads; picture mold, channels, channel and lath clips, hanger rods; furring, furring extension rods, metal furring staples; building anchors, anchor slots and inserts; header angles; tie wire; joist bearing plates, bridging clips, bridging wire; wall ties.

CAISSONS, BRIDGE.

CARS, MINE AND INDUSTRIAL—Built to any specifications.

CARS, STEEL FREIGHT—Ballast, flat, gondola, hopper, steel box, tank and dump cars.

CARS, STEEL PASSENGER—Passenger, baggage, express, mail, dining, private, special and combination cars.

CAR PARTS—Pressed steel parts; underframes; truck and body bolsters; castings; forgings; coupling links and pins; brake and brake lever pins; trucks.

CAR WHEELS, WROUGHT STEEL—Rolled steel wheels for freight cars, passenger cars, engine, tender and trailer trucks, electric cars, mine locomotives and mine cars, and cinder, ore and other industrial cars.

CASTINGS—Carbon and alloy steel (acid and basic open hearth and electric); manganese steel; iron; brass and bronze; rough as cast or machined. Centrifugal cast bronze sleeves and liners. Abrasion-resisting castings. Tunnel segments, iron and steel.

CONCRETE REINFORCING MATERIALS—Round and square reinforcing bars; bar supports and spacers, slab bolsters, floor clips, spreader extensions; welded wire fabric; removable and permanent steel tiles, removable steel column forms; column spirals; concrete inserts.

DERRICKS—Miscellaneous.

DOCKS—Ore.

DOORS, STEEL—Bur-Vett, vertical lift.

DREDGES—Steel.

DRYERS—Rotary- (Kilns).

FABRICATED STEEL CONSTRUCTION—All kinds.

FENCE, WOVEN WIRE—Bethanized woven wire field and poultry fence. Bethanized stiff-stay field and poultry fence. Bethanized lawn fence and fence gates.

FERRO-MANGANESE.

FLANGED PRODUCTS—Tank heads, boiler heads, dome sheets, manheads, yokes, bolts and saddles. Miscellaneous flanged plate work.

FLUMES—Steel.

FORGINGS—Carbon and alloy steel; drop, upsetter, hammered, and hydraulically pressed forgings; seamless vessels for oil refineries; high pressure seamless boiler drums and chemical vessels, crankshafts, rotors for turbines and generators.

PARTIAL LIST OF PRODUCTS—Continued

Frogs and Switches—Frogs, switches, hook-flange guard rails, crossings. Bethlehem and New Century switch stands. Silico-manganese special trackwork, portable trackwork. Switch heaters, guard rail chairs, compromise joints, steel ties, gage rods, rail braces.

Gas Holders—Pressure, multiple lift. Pressure spheres.

Gates, Steel—For farm, garden, lawn and poultry fencing.

Gears and Pinions—Cut and cast bevel; spur with straight or herring-bone cut teeth, any size; mill reduction gearing and pinions; gears for bridge operating machinery.

Highway Building Materials—Steel—Bar mats, bolsters, supports, clips, spacers; welded wire fabric; road mesh; expansion or contraction joints, tubes, fillers, dowels, dowel bars; road strip; guard fencing; Kalguard (steel highway guard).

Hulls, Steel—Dredge, boat and barge.

Hydraulic Machinery.

Ingot Molds, Stools and Bottom Plates—All sizes.

Joists (Open-web steel)—"Mac Mar", "Kalman" and long span. Open-web expanded and welded steel joists.

Kettles—Galvanizing.

Kilns—Cement, rotary.

Nails, Wire—All kinds and sizes; standard and special; galvanized, cement-coated, annealed, blued and bright. Miscellaneous wire brads.

Nuts—Hot forged, hot pressed, and cold punched; semi-finished; bar, jam, slotted, chamfered and trimmed, blank, special lock-nuts; oil-quenched and Bethlehem treated. Dardelet self-locking threaded nuts.

Oil Burning Equipment—Bethlehem (Dahl) mechanical atomizing oil burning systems for stationary and marine service.

Oil Refinery Equipment.

Oil Well Derricks and Equipment.

Pig Iron—Basic, bessemer, semi-bessemer, foundry, low phosphorus, malleable, malleable bessemer, and Mayari pig iron for superior alloy-iron castings.

Piling, Steel—Bethlehem steel sheet piling—straight, arched, deep-arched, bent webs; rolled and fabricated corners; tees, tapers; new and used, for bulkheads, jetties, cofferdams, and similar applications. Steel **H**-piling, Steel **Z**-piling.

Pipe, Steel—Butt-welded and lap-welded, black and galvanized; copper-bearing pipe; Welded and riveted pipe of large diameter.

Penstocks—Steel.

Plates, Steel—Universal and sheared plates for all purposes. Steel plate work. Floor plates. Slabs. Column bases and covers, steel paving plates.

PARTIAL LIST OF PRODUCTS—Continued

Pole Line Material—Black and galvanized.

Pontoons, Steel.

Posts, Steel Fence—Farm, garden, lawn and poultry fence posts, snow fence posts, highway sign posts.

Rails and Accessories—Controlled cooled rails; standard tee rails; girder, girder-guard and high tee rails; light rails; splice bars, rail clips, tie plates, Bethco rail anchors.

Rivets, Steel and Iron—Small and large; boiler, structural, ship, bridge, tank and tap. High tensile rivets.

Rods—Bridge, truss, loop and roof; round and flat tie; silo; upset; wire; guy.

Rolls—Steel and iron.

Sand, Washed Limestone.

Screws, Cap—Flat fillister, fillister and hexagon heads.

Semi-Finished Steel—Ingots, blooms, billets and slabs. Bessemer, open hearth, electric furnace, carbon steels. Re-rolling and forging quality; Sheet bars. Skelp, grooved, universal and sheared.

Shafting, Steel—Cold drawn; forged solid or hollow; turned and polished.

Sheets, Steel—Hot rolled, hot-rolled annealed, cold-rolled, heavy cold-rolled sheets, deoxidized; furniture, heavy furniture, japanning, porcelain enameling sheets; automobile sheets; galvanized flat and formed sheets; painted sheets; painted formed sheets; painted roofing and siding; special-finish sheets; sheets of Beth-Cu-Loy (copper-bearing steel). Culvert stock. Stormproof roofing and siding and Stormproof adjustable ridge roll. Blued stove-pipe sheets, red hard sheets, Mayari R sheets, corrugated sheets, V crimp sheets, roll roofing, rock-face stone siding, rock-face brick siding, plain brick siding, plain ridge roll, corrugated ridge roll, plain ridge cap, flashings, formed and rolled valleys.

Smoke Stacks, Steel—Guyed and self-supporting.

Spikes—Standard railroad, screw track, universal screw, tie-plate screw, boat, dock and wharf spikes. Round and gutter or eaves trough wire spikes.

Standpipes, Steel.

Stainless Steels—Bethadur and Bethalon, covering practically every need for heat-resisting and corrosion-resisting steels, including free-machining grades.

Staples—Fence, fence post, ribbon wire, poultry netting, galvanized hoop, and metal lath.

Steelworks Construction—Blast furnaces, steel converters, bins, furnace ladles, hot metal mixers, gas purifiers and scrubbers, hot blast stoves, tanks, charging boxes, ore handling bridges, mill buildings, ore docks and steel plate work.

Stills, Steel—Oil, tar, riveted.

PARTIAL LIST OF PRODUCTS—Concluded

Strip—Hot-rolled, cold-rolled strip. Black as rolled, annealed, heat-treated. Coils and flat.

Structural Steel Shapes—Bethlehem wide-flange beams, girders and H-columns, joists and stanchions; standard beams, channels, and angles; car and shipbuilding shapes; standard and special T-and Z-bars.

Sucker Rods—Mayari; nickel-chromium; copper-bearing sucker rods; sub-polished and pony rods, pull rods with turtle backs; box and pin type; double pin type with coupling.

Tanks, Steel Plate—All kinds.

Tin Plate—Hot pack and cold reduced; coke tin plate; canners special; galvanizing; black plates (hot rolled annealed, deoxidized, cold reduced (Beth-Co-Lite); pickled annealed, pickled annealed cold rolled annealed [full finish], enameling and lithographing stock). Terne plate, special coated.

Tool Steels—Bethlehem special high speed steel. Carbon and alloy tool steels. Air hardening, water hardening, oil hardening, cold cutting and die, hot die, shock resisting, non-deforming, quarrying, cobalt magnet, valve and special tool steels. Tool steel billets, all grades.

Tools—Rivet sets, punches and dies, chisel blanks and chisels; hot and cold friction saws; steel stamps (letters and figures for hot and cold work). Slitting shears, shear blades, and special high speed tool holder bits, special tools.

Tipples, Steel—Coal and mine tipples and head frames.

Towers and Poles—Structural steel; transmission line; flood-light; airway beacon; radio, etc.

Tubes and Tubing, Steel—Boiler, locomotive boiler, oil country, superheater, gas and well; welded.

Turntables—Railroad—Bethlehem Twin-span Turntables. Balanced and continuous turntables.

Washers—Iron and Steel—Round plate.

Wire—Made from bessemer, basic open hearth or acid open hearth grades of steel: In various finishes such as plain; bright-processed; annealed; normalized; galvanized; Bethanized (special zinc-coated); soft-processed; lime-bright annealed; annealed, cleaned and lime coated; annealed, cleaned and oiled; and high carbon patented. Bolt, screw, chain, extra-soft rivet, hard bright nail wire; stapling wire, border wire, Apex and Bethlehem spring wire, telephone wire, heading wire, copper-bearing and special wire. Clothes-line wire. Barbed wire, Silver Star bale ties. Welding wire.

Wire Rods—Basic, bessemer and acid open hearth.

Wire Specialties—Formed in all sizes of wire from 20 gauge to ⅜-inch. Fasteners, handles, hangers, hooks, hoops, links, loops, picket or tent pins, rings, skewers, double-pointed tacks.

BETHLEHEM STEEL COMPANY

General Offices

BETHLEHEM, PENNSYLVANIA

District Offices

Albany	Standard Building
Atlanta	Candler Building
Baltimore	Mercantile Trust Building
Boston	75 Federal Street
Bridgeport	Security Building
Buffalo	Bell and Abby Streets
Chicago	Wrigley Building
Cincinnati	Union Trust Building
Cleveland	Terminal Tower
Columbus	First National Building
Dallas, Tex.	Tower Petroleum Building
Detroit	General Motors Building
Hartford	125 Trumbull Street
Honolulu	Schuman Building
Houston	400 Bringhurst Street
Indianapolis	Circle Tower
Johnstown	
Kansas City, Mo.	Commerce Building
Los Angeles	Downey Road and E. Slauson Ave.
Milwaukee	First Wisconsin National Bank Building
Nashville	Noel Hotel
New York	25 Broadway
Philadelphia	Broad Street Station Building
Pittsburgh	Oliver Building
Portland, Ore.	Pacific Building
St. Louis	Telephone Building
St. Paul	First National Bank Building
Salt Lake City	Kearns Building
San Antonio	Smith-Young Tower
San Francisco	20th and Illinois Streets
Savannah	580 W. River Street
Seattle	28th Avenue S. W. and W. Andover Street
Syracuse	Hills Building
Toledo	Bell Building
Tulsa	National Bank of Tulsa Building
Washington, D. C.	American Security Building
Wilkes-Barre	Miners National Bank Building
York	Small Building

Export Distributor

BETHLEHEM STEEL EXPORT CORPORATION
25 Broadway, New York City

Bethlehem Steel Company Administration Building, Bethlehem, Pa.

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